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AUTHOR Goodson, Ludy
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ABSTRACT

This student guide is for Unit 5, Fuel and Carburetion Systems, in the Engine Tune-Up Service portion of the Automotive Mechanics Curriculum. It deals with inspecting and servicing the fuel and carburetion systems. A companion review exercise book and posttests are available separately as CE 031 218-219. An introduction tells how this unit fits into the total tune-up service, defines new terms, and provides work activities on the introductory information. Ten performance objectives are covered: service carburetor air cleaner; service fuel filter; measure fuel flow and pressure; remove, repair, and install fuel lines; remove or replace fuel pump; adjust carburetor idle mixture and idle speed; clean and adjust automatic choke unit; remove and install carburetor; clean and overhaul carburetor; and inspect and repair or replace manifold heat control valve. Each objective is addressed in a separate section that includes these materials: introduction to the performance objective, performance checklist, list of tools and equipment needed to do the work activities for this performance objective, reading list, information sheets, and work activities that give hands-on practice in doing one part of the performance objective. (YLB)

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ENGINE TUNE-UP SERVICE

Unit 5: Fuel and Carburetion Systems

Student Guide

Automotive Mechanics Curriculum

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Instructional Development: Ludy Goodson
Content and Instructional Review: Roger Richardson, Theodore R. May, E. Miles Bacon
Editing: Melissa M. Wheeler
Graphic Design: John S. Matlock
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HOW TO USE THIS BOOK

As you work through this Student Guide, you'll find directions about when to do certain activities and when to use the Review Exercise Book. Be sure to follow these directions carefully since they lead you step by step to the completion of a performance objective.

Read the introduction on page 1 before you start working through this Student Guide. It will tell you how Unit 5, Fuel and Carburetion Systems, fits into the total tune-up service. There are also separate introductions to each performance objective. These introductions give you the basic concepts and terms you'll need to know before you begin work.

Performance Objectives

The performance objectives (abbreviated *P. O.)* in this Student Guide are statements of what you'll need to do on the job. All the materials in the Student Guide and in the Review Exercise Book are carefully designed to help you do well on performance objectives. So be sure to complete all the activities, and try to do well on each of them.

After you have finished all the activities for a performance objective, your instructor will test you to see whether you have mastered the necessary skills. A performance checklist will

be used to check your work. Each introduction to a performance objective includes a copy of the checklist. Be sure to read it so that you'll know exactly what you'll be tested on.

A list of tools and equipment that you'll need is also provided in the introduction for each objective. If you want more information about a performance objective, be sure to refer to the reading list in that introduction.

Work Activities

You'll need to check with your instructor before and after you do any work activity. Automotive mechanics is a hazardous trade. That's why it's important for you and your instructor to be sure that you do the work activities safely. Each work activity gives you "hands-on" practice in doing one part of a performance objective. Do each work activity as required in the Student Guide, and you'll find it easier to do the complete performance objective later. Never hesitate to ask your instructor about anything you're unsure of in a work activity.

Reading List

The materials listed below are used as instructional references throughout this guide. You will find the author, title, and relevant page numbers of these references listed under the ***Reading List*** heading of each performance objective. Materials listed as general references will be used throughout the ***Engine Tune-Up Service*** area. Those listed as special-purpose references apply only to specific content areas.

General References

Crouse, William H. ***The Auto Book.*** New York: McGraw-Hill, Inc., 1974.

Crouse, William H. ***Automotive Mechanics.*** 7th ed. New York: McGraw-Hill, Inc., 1975..

Ellinger, Herbert E. ***Automechanics.*** 2d ed. Englewood Cliffs, New Jersey: Prentice-Hall, Inc., 1977.

Stockel, Martin W. ***Auto Mechanics Fundamentals.*** South Holland, Illinois: The Goodheart-Willcox Co., Inc., 1974.

Stockel, Martin W. ***Auto Service and Repair.*** South Holland, Illinois: The Goodheart-Willcox Co., Inc., 1975.

Toboldt, William K., and Johnson, Larry. ***Automotive Encyclopedia.*** South Holland, Illinois: The Goodheart-Willcox Co., Inc., 1975.

Special-Purpose References

Crouse, William H. ***Automotive Electrical Equipment.*** 8th ed. New York: McGraw-Hill, Inc., 1976.

Crouse, William H., and Anglin, Donald L. ***Automotive Engines.*** 5th ed. New York: McGraw-Hill, Inc., 1976.

Crouse, William H., and Anglin, Donald L. ***Automotive Fuel, Lubricating, and Cooling Systems.*** 5th ed. New York: McGraw-Hill, Inc., 1976.

Ellinger, Herbert E. ***Automotive Systems: Fuel, Lubrication, and Cooling.*** Englewood Cliffs, New Jersey: Prentice-Hall, Inc., 1976.

Johnson, James A. ***Automotive Diagnosis and Tune-Up.*** New York: McGraw-Hill, Inc., 1972.

Wetzel, Guy F. ***Automotive Diagnosis and Tune-Up.*** 6th ed. Bloomington, Illinois: McKnight Publishing Co., 1974.

Whited, N. W. ***Automotive Oscilloscope.*** New York: Delman Publishing Company, 1972.

Review Exercise Book

As you work through this Student Guide, you'll frequently be directed to complete an exercise in your Review Exercise Book. Before you begin the first exercise, read the introduction at the front of the Review Exercise Book. The introduction gives you information about how to use the book so that you'll get the most out of it.

Pretest

Before you go any further, ask your instructor whether you can take the pretest for P. O. 32. The pretest will let you know what to look for in these materials. If you do well on the pretest, your instructor may let you skip some of the study material in the Student Guide.

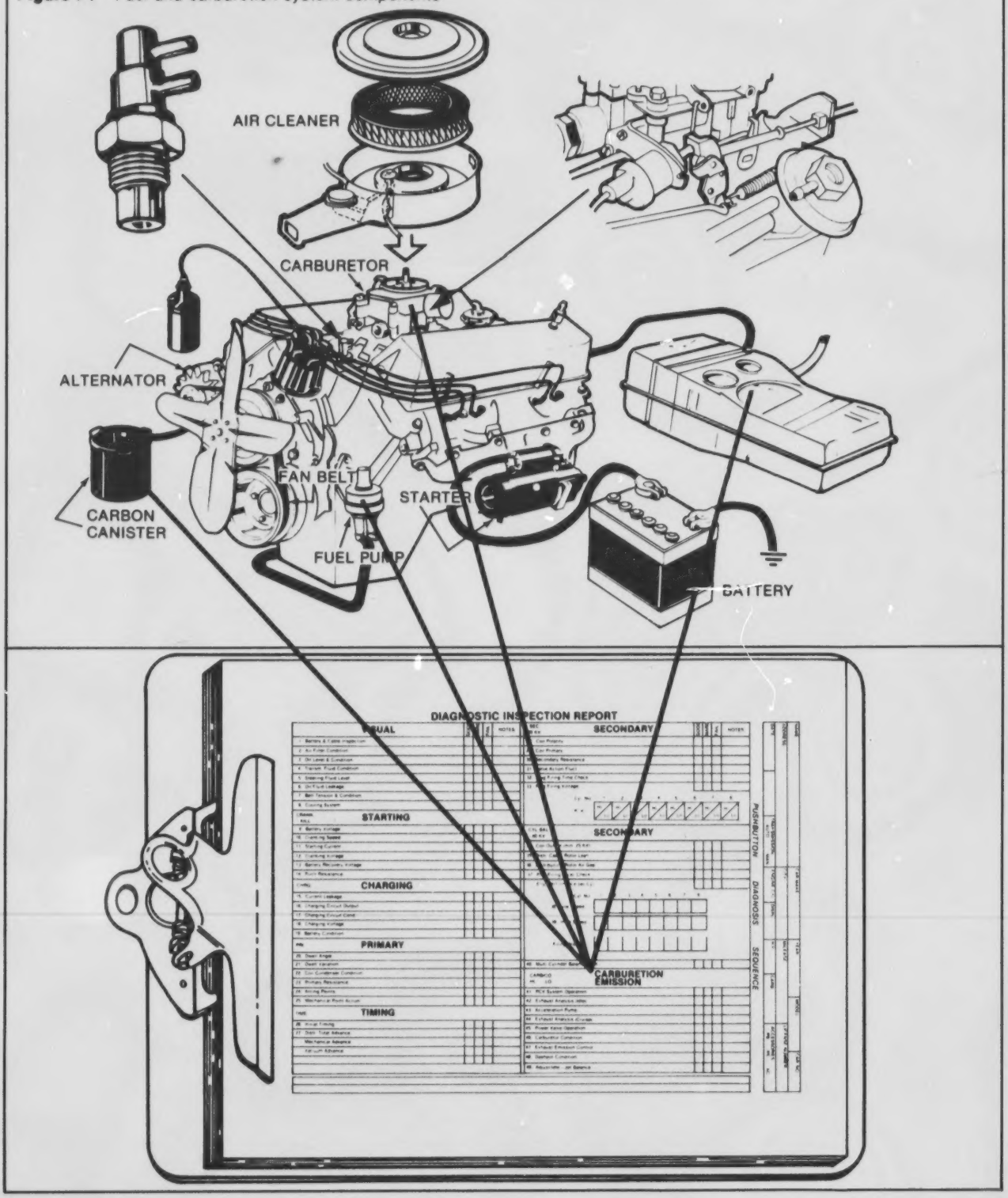
Your instructor will let you know when to begin studying the materials in this Student Guide.

Good Luck!

INTRODUCTION TO UNIT 5

The fuel and carburetion systems should be inspected and serviced as part of the total tune-up service for a vehicle. Because the fuel and carburetion systems are so closely related, this introduction describes each system separately to help you recognize the differences between them. Figure I-1 shows both systems. This figure also shows that fuel and carburetion are considered part of the exhaust inspection, since they produce the exhaust gases that enter the exhaust system. As you go through each performance objective in Unit 5, you will learn how to inspect and service the components in these systems.

Figure I-1 Fuel and carburetion system components



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Fuel and Carburetion System Components

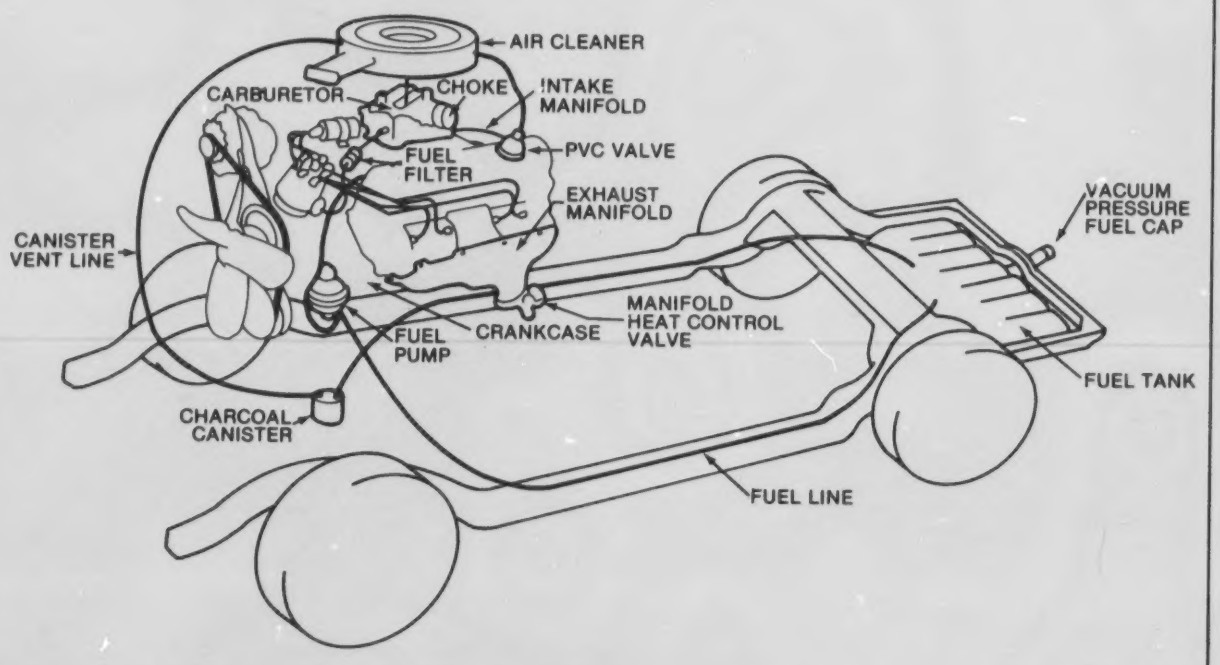
The fuel and carburetion systems have many components. If you understand the basic functions of each system as you read through this unit, you will be able to more easily identify which system different components belong to.

The vehicles you are used to servicing have gasoline engines. Fuel system components carry this gasoline from the fuel tank to the engine cylinders, where a spark (ignition) starts the quick burning of the gasoline (combustion).

But gasoline must be mixed with a certain amount of air before combustion can be complete. That's the purpose of the carburetion system. It first changes the liquid gasoline to a vapor. Then it mixes the vapor with a certain amount of air to make it combustible, or burnable.

The burning of this combustible mixture not only produces power in the cylinders, but also produces other gases. Some of these gases go past the piston rings into the crankcase and are called ***blow-by*** gases. Other gases are emitted (let out) from the exhaust system into the air and are called ***exhaust*** gases. These blow-by and exhaust gases are known as emissions. Emissions are also known as pollutants because they contain chemical compounds that pollute the air.

Figure I-2 Basic components of the fuel and carburetion systems



The basic components of the fuel and carburetion systems are shown in Figure I-2. The components of the fuel and carburetion systems can be grouped into three categories: those that clean and carry the fuel (fuel system components), those that clean and carry the air (carburetion system components), and the intake manifold, which is part of the carburetion system and carries both fuel and air.

The Fuel System

The fuel is filtered and carried from the tank to the carburetor by the:

- fuel filter
- fuel lines and hoses
- fuel pump

In this unit you will learn how to inspect and repair these components. You should already be able to inspect three other components of the fuel system: the fuel tank, fuel filler cap, and fuel gauge.

The Carburetion System

Air is filtered and mixed with the fuel by these components of the carburetion system:

- carburetor air cleaner
- carburetor
- automatic choke unit

In this unit, you will learn how to inspect and repair these components.

The *intake manifold* is also part of the carburetion system. It distributes the air-fuel mixture so that it will flow easily into the cylinders. You will not be required in this unit to learn how to service the intake manifold.

Turn to your Review Exercise Book and complete Exercise 1.

WORK ACTIVITY

Do not begin this work activity until you have your instructor's approval. If you have any difficulty, review the pages listed next to the work activity. If you still have difficulty, ask your instructor for help.

Locate the components listed below in at least one vehicle (pages 3-4):

fuel gauge	**fuel pump**	**choke unit**
fuel tank	**carburetor**	**intake manifold**
fuel lines	**carburetor air cleaner**	**crankcase**
fuel hoses		

Check your work with your instructor.

After you have finished this work activity, turn to your Review Exercise Book and complete the pretest for Performance Objective 23.

PERFORMANCE OBJECTIVE 23
SERVICE THE CARBURETOR AIR CLEANER

INTRODUCTION TO P.O. 23

Purpose of Carburetor Air Cleaner

Dirt and dust in the air must be kept from getting into the engine. If dirt gets between two moving parts in an engine, it causes extra friction and the parts begin to wear away. Later, the dirt could clog up the oil filter as it passes through the engine.

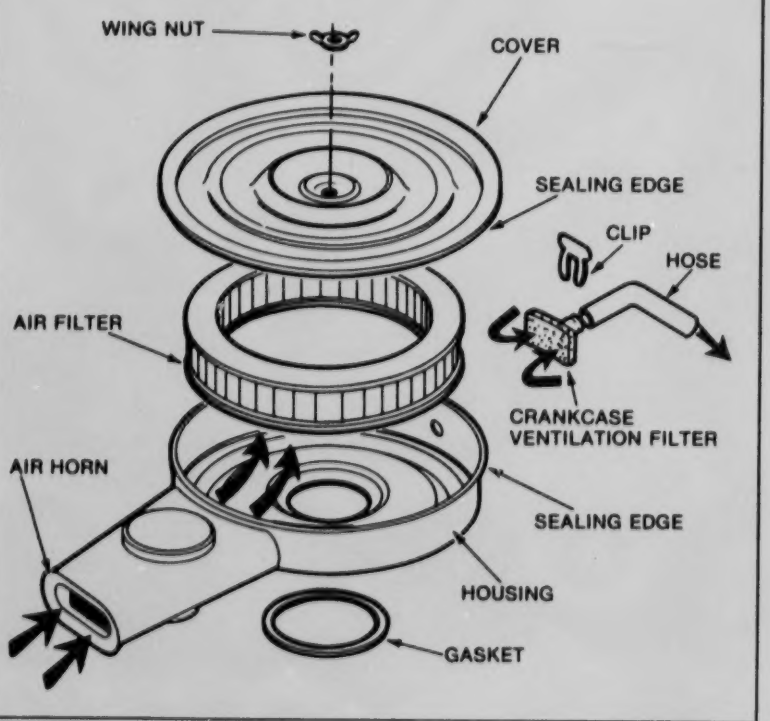
The purpose of the carburetor air cleaner is to keep the air clean. It does this by filtering the air before it goes through the carburetor to the engine. In other words, it lets the air pass through, but it traps anything else.

Operation of Carburetor Air Cleaner

The main parts of a carburetor air cleaner are the housing, the housing cover, the air filter element, and the air ducts.

The housing holds the air filter element. The air filter element traps dirt and dust in the air. The air ducts allow air to flow into and out of the carburetor air filter.

Figure 23-1 Carburetor air cleaner and components



The arrows in Figure 23-1 show the flow of air into and out of one type of air cleaner. As soon as the air filter element gets too dirty, it should be cleaned or replaced.

Several types of air filter elements may be used. The newest and most common type is the ***paper filter element.*** Other types are the polyurethane type and the oil bath type. The ***polyurethane*** type is made of foamed plastic. The ***oil bath*** type is made of wire mesh. Usually, the bottom part of this type of filter rests in oil.

The paper filter element will be emphasized during this discussion. If you can remove, inspect, clean, and replace the paper filter element, you will be able to service the carburetor air cleaner in most vehicles.

Location of Carburetor Air Cleaner

Carburetor air cleaners are installed on the vehicle's engine carburetor. As you look for carburetor air cleaners on different vehicles, you will find that the air cleaners have different sizes and shapes. But you will usually be able to recognize the air cleaner by its round, narrow, doughnut shape. You will probably be able to see the air duct where the air comes into the carburetor, though you may not be able to clearly see where the air flows out.

After you have finished the activities for Performance Objective 23, your instructor will use a checklist like the one on the next page to evaluate your work.

Performance Checklist—P. O. 23

The instructor will provide either a live vehicle or a live engine. Inspect and service the carburetor air cleaner and correct any problems you find. All of the performances below must be accomplished.

Student Performances

1. Removes carburetor air cleaner.
2. Removes carburetor air filter element, gauze wrapper (if so equipped), and PCV filter (if so equipped).
3. Inspects and cleans or replaces filter element(s) as necessary.
4. Inspects carburetor air cleaner assembly for defects.
5. Installs cleaned or new filter element(s).
6. Installs carburetor air cleaner assembly.
7. Uses proper tools and equipment.
8. Follows all appropriate safety precautions.
9. Does performance in an acceptable amount of time.

Instructor Ratings

Acceptable	Not Acceptable	Omit
	SAMPLE	

Tools and Equipment

For this objective, you will need to use the tools and equipment listed below. You will be given the procedures for using special tools and equipment as you work through the activities.

Basic Hand Tool Set

Basic Equipment

fender covers
extension light

Reading List

If you would like additional information as you work through this performance objective, use the references below.

General References

Crouse, ***Automotive Mechanics,*** pp. 157-59, 189-91.
Crouse, ***The Auto Book,*** pp. 194-96, 308-11.
Ellinger, ***Automechanics,*** pp. 132-33.
Stockel, ***Auto Mechanics Fundamentals,*** pp. 150-51.
Stockel, ***Auto Service and Repair,*** pp. (20-30)-(20-33).
Toboldt and Johnson, ***Automotive Encyclopedia,*** pp. 271-74.

Special-Purpose References

Crouse and Anglin, ***Automotive Fuel, Lubricating, and Cooling Systems,*** pp. 51-56, 184-87.
Ellinger, ***Automotive Systems: Fuel, Lubrication, and Cooling,*** pp. 104-5.

Personal and Service Safety Practices

Safety When Working with the Carburetor Air Cleaner

- While you work under the hood, use fender covers to protect the finish of the fenders.
- After removing the carburetor air cleaner housing, place it where it will not get stepped on.
- Do not use an air hose to clean the paper filter element. The blast of air could blow dirt into someone's eyes or could tear the paper in the filter element.

Turn to your Review Exercise Book and complete Exercise 2.

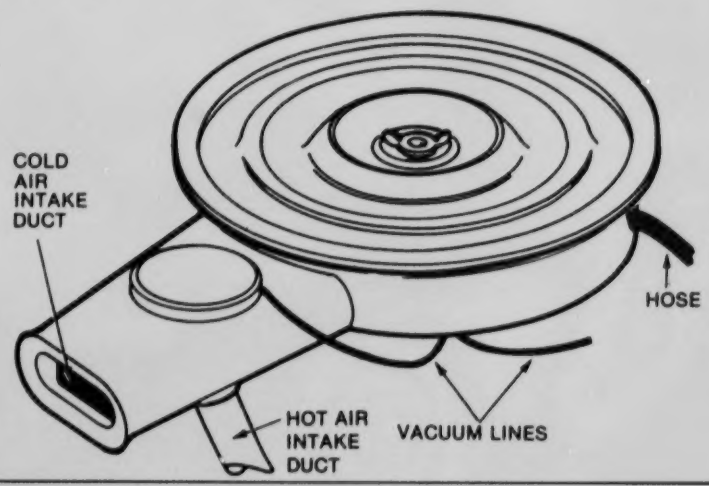
REMOVING AND INSPECTING THE CARBURETOR AIR FILTER

Removing the Carburetor Air Cleaner Assembly

In order to remove and inspect the carburetor air filter, you must remove the engine carburetor air cleaner assembly.

STEP 1 To remove the carburetor air cleaner assembly, you must first disconnect the different hoses, lines, and ducts (see Figure 23-2). Inspect the vehicle and check the technical service manual to help you identify these parts. You may need to remove a front air duct, the PCV hose (positive crankcase ventilation hose), and the vacuum lines underneath the cleaner assembly.

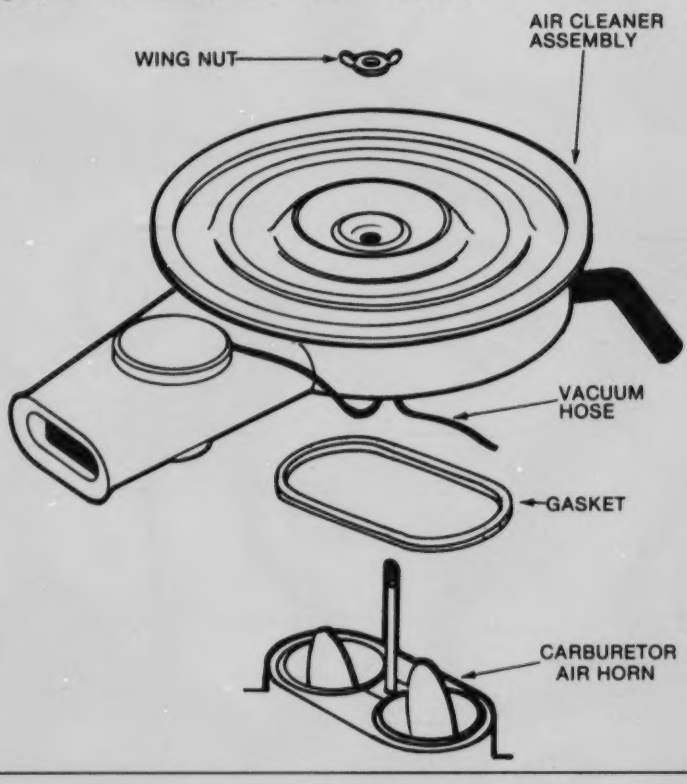
Figure 23-2 Disconnecting the hoses, lines, and ducts



CAUTION: Mark the vacuum lines with masking tape so you will know exactly where to reinstall them later.

STEP 2 After you have disconnected the necessary parts, you must remove the air cleaner assembly. To do this, simply unscrew the wing nut, lift the air cleaner, and put the assembly and wing nut in a safe place (see Figure 23-3).

Figure 23-3 Disassembled air cleaner assembly



STEP 3 Remove the air cleaner gasket. It rests on top of the carburetor air horn, just under the air cleaner assembly. Set it and the wing nut in a safe place.

STEP 4 Remove the top cover of the housing (the housing cover) and lift the filter element out of the housing. Be careful with the paper. Don't crush the paper or punch a hole in it.

Follow the same basic removal procedures for other types of carburetor air filters.

Inspecting the Carburetor Air Cleaner Assembly

After you have removed the air cleaner assembly and the air filter from the housing, you can begin inspecting the air filter element (see Figure 23-4).

Figure 23-4 Air filter element in the air cleaner assembly

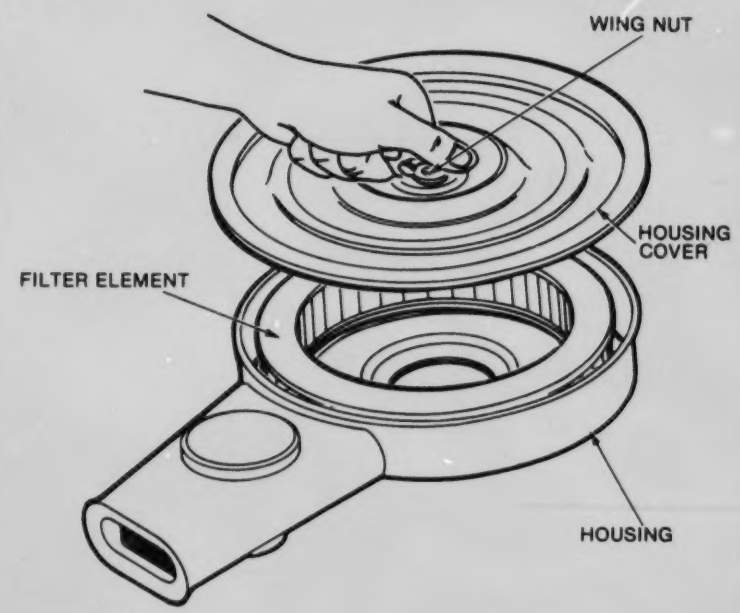


Figure 23-5 Inspecting the air filter element

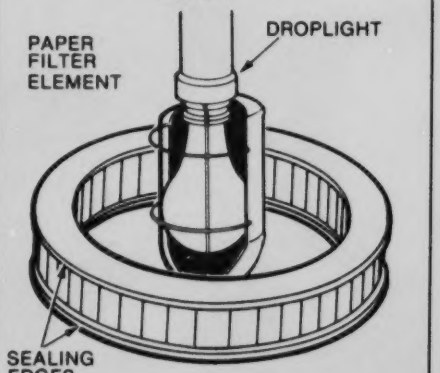
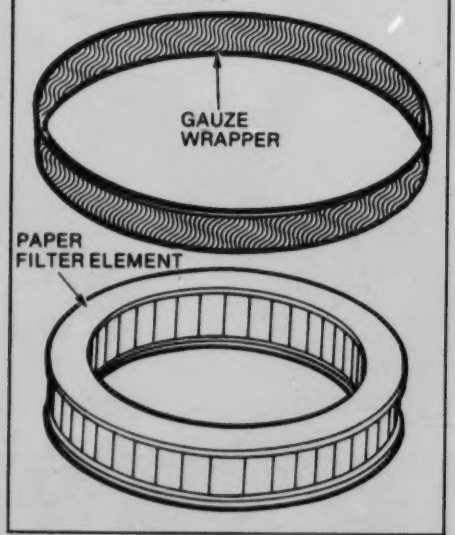


Figure 23-6 Air filter with gauze wrapper

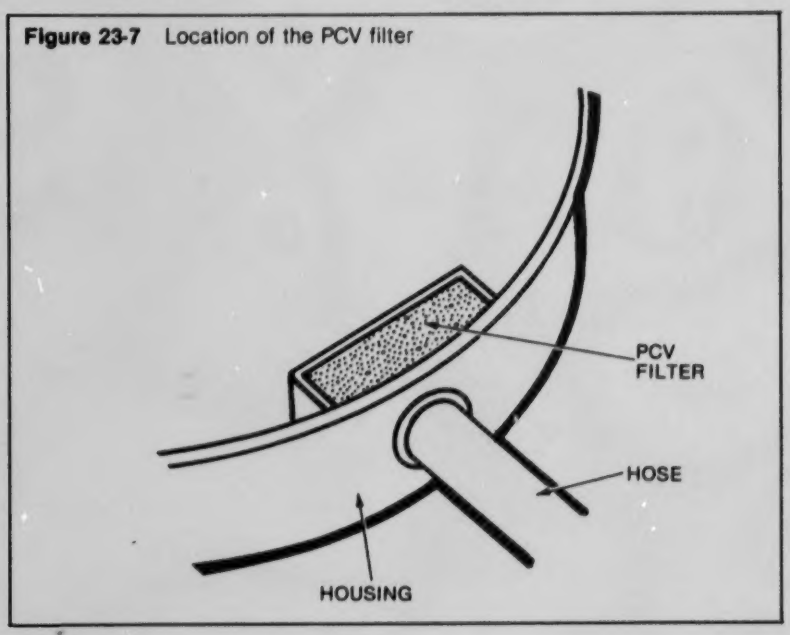


STEP 1 Hold a droplight on one side of the filter element. Look for dust, dirt, grime, and worn spots around the top and bottom sealing edges of the air filter and on the paper filter element itself (see Figure 23-5). (These sealing edges are also known as gaskets. They are made of rubber.) If the filter has holes or worn spots, it should be replaced. If the filter is coated with a lot of dirt and grime, it should be cleaned or replaced. If the paper filter element is wet with oil, it should be replaced.

STEP 2 Check the filter element to see if it has a gauze wrapper around it, as shown in Figure 23-6. The gauze wrapper must be removed and cleaned.

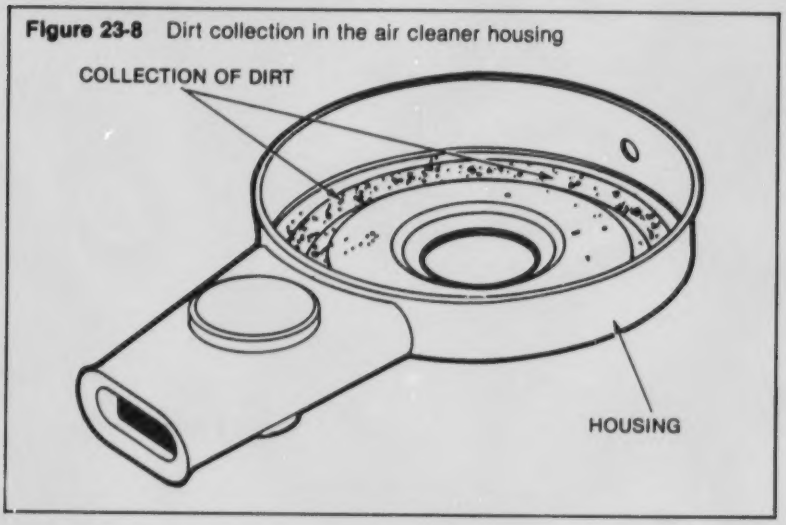
STEP 3 Check inside the carburetor air cleaner housing to see if there is another small filter element. This element is called the ***PCV filter element*** or ***crankcase ventilation filter,*** and is shown in Figure 23-7. It too is used to clean the air. When the PCV filter gets quite dirty, it should be replaced. Check with your instructor as you inspect the filter for help in deciding whether it is clean enough to be used again or whether it should be replaced.

Figure 23-7 Location of the PCV filter



STEP 4 Finally, check the housing for collections of dirt and dust, as shown in Figure 23-8. Remember, the carburetor air filter is just one part of the air cleaner. The other parts you need to check are the housing, the PCV filter, the sealing edges, the gauze wrapper (if there is one), and the air cleaner gasket (from the top of the carburetor air horn).

Figure 23-8 Dirt collection in the air cleaner housing



Turn to your Review Exercise Book and complete Exercise 3.

WORK ACTIVITIES

Do not begin any of these work activities until you have your instructor's approval. If you have any difficulty, review the pages listed next to each work activity. If you still have difficulty, ask your instructor for help.

1. Remove the carburetor air cleaner assembly. (pages 9-14) *Check your work with your instructor.*

2. Remove the carburetor air filter element. (pages 13-15) *Check your work with your instructor.*

3. Inspect the carburetor air cleaner assembly and list the visible defects of each part. (pages 15-16) *Check your work with your instructor.*

After you have finished these activities, continue reading the text.

CLEANING AND REPLACING CARBURETOR AIR CLEANER COMPONENTS

Cleaning the Paper Filter Element

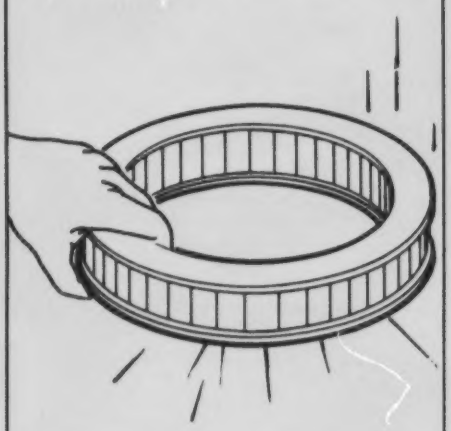
STEP 1 If the paper filter element has a gauze wrapper around it, you must:

- Remove the wrapper.
- Wash the wrapper in solvent.

STEP 2 Clean the paper element. The safest, simplest way to do this is to gently tap the element on a flat, solid surface. Do this several times while holding the element firmly but gently, as shown in Figure 23-9. Be careful not to crush the paper element.

REMEMBER: Never use an air hose to clean a paper element.

Figure 23-9 Gently tapping the filter



If there is still a heavy buildup of dirt and grime, the filter should be replaced.

Note: Other types of elements must be cleaned differently. For example, the polyurethane type of element has a holder. But the element, not its holder, is the part that must be soaked in a solvent. The oil bath element, another type, also needs to be soaked in a solvent.

STEP 3 To clean the housing, (inside and outside), simply wipe it with a cloth and solvent. Remember also to wipe the housing cover, as shown in Figure 23-10.

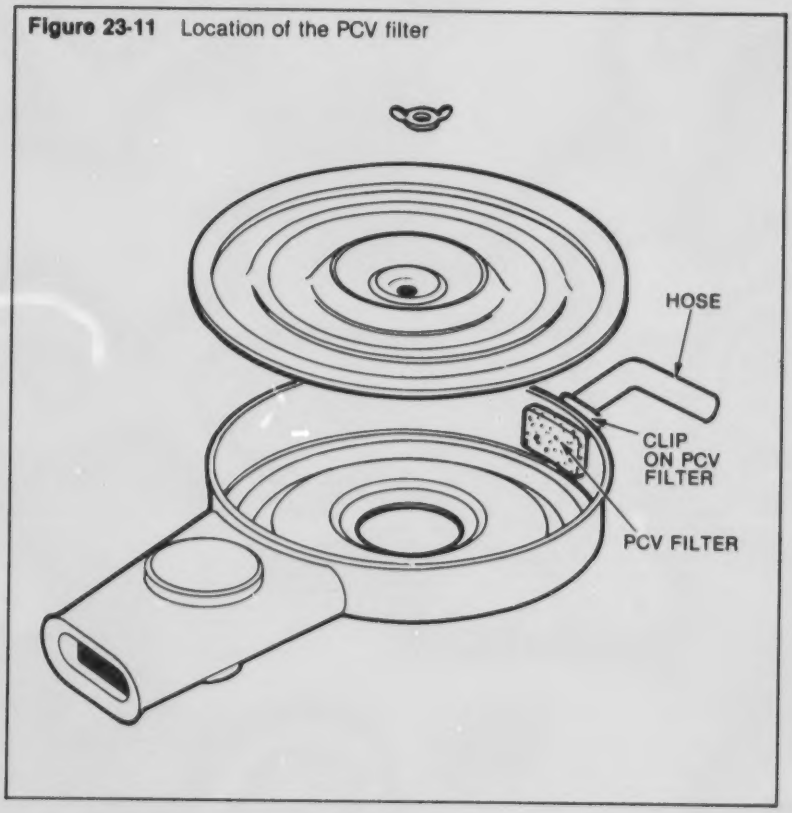
Figure 23-10 Cleaning the air filter housing cover

Removing and Replacing the PCV Air Filter

Before replacing any other parts, you must replace the PCV air filter if it is no longer in good condition.

STEP 1 To remove the PCV air filter, refer to the technical service manual for the vehicle you are working on. Check under the heading ***Crankcase Ventilation.*** The manual may refer to the PCV filter as the ***crankcase ventilation filter*** or the ***inlet filter.*** The PCV filter is usually clipped to the inside of the housing and is connected to a hose, as shown in Figure 23-11.

Figure 23-11 Location of the PCV filter



STEP 2 Remove the hose clamp and the hose. Then remove the filter retainer clip and the PCV filter.

STEP 3 The technical service manual will tell you whether to clean or replace the PCV air filter. On an older car, you may be instructed to clean it with solvent. On cars made in 1969 or after, the PCV air filter must be replaced.

STEP 4 To replace the PCV air filter, simply reverse the steps you followed for removing it.

Replacing or Installing Carburetor Air Filter Element and Housing

In the tune-up section of a technical service manual you will find information that explains when to replace the air cleaner. These specifications will look something like this:

FILTER OR CLEANER	SERVICE INTERVAL (MILES)
Air Cleaner	Replace 30,000
①Inspect and replace sooner if needed.	

As you can see, the air filter element should be replaced after every 30,000 miles. In especially dusty areas, the filter may need to be replaced sooner.

Use the following steps when putting in a new air filter element or reinstalling an old element and putting the cleaner assembly on again.

STEP 1 Place the air filter in the housing again. (Also, put the gaskets in as needed if they are separate from the element.)

STEP 2 Reinstall the carburetor air cleaner housing by reversing the removal procedures.

STEP 3 Connect all hoses, lines, and ducts correctly.

STEP 4 Replace the carburetor air hose gasket.

STEP 5 Place the housing cover on top of the housing again.

STEP 6 Install and tighten the wing nut, but be careful not to tighten it too much. If it is tightened too much, it can warp the top of the carburetor and keep the choke from working properly.

Turn to your Review Exercise Book and complete Exercise 4.

WORK ACTIVITIES

Do not begin any of these work activities until you have your instructor's approval. If you have any difficulty, review the pages listed next to each work activity. If you still have difficulty, ask your instructor for help.

4. Remove and clean the air filter gauze wrapper. (page 18) *Check your work with your instructor.*

5. Clean the air filter element. (page 18) *Check your work with your instructor.*

6. Remove the PCV filter and replace it if necessary. (page 19) *Check your work with your instructor.*

7. Install the air filter element and the carburetor air cleaner assembly. (pages 18-20) *Check your work with your instructor.*

After you have finished these activities, ask your instructor to return your pretest on Performance Objective 23. Complete the questions that you missed or were unable to answer the first time you took the pretest. Check your answers with your instructor when you finish. Your instructor will then tell you if you are ready to be checked off the performance checklist or if you need to correct some of your answers first.

If you are told by your instructor that you are ready for the performance checklist, carefully tear the checklist out of your Review Exercise Book and give it to your instructor.

PERFORMANCE OBJECTIVE 24
SERVICE THE FUEL FILTER

INTRODUCTION TO P. O. 24

In this performance objective, you'll learn how to service fuel filters.

After you have finished all the work activities for Performance Objective 24, your instructor will use a checklist like the one below to evaluate your work.

Performance Checklist—P. O. 24

The instructor will provide a live vehicle or live engine. Inspect and service the fuel filters and correct any problems you find. All of the performances below must be accomplished.

Student Performances

Instructor Ratings

	Acceptable	Not Acceptable	Omit
1. Removes carburetor air cleaner assembly.			
2. Disconnects fuel line at carburetor.			
3. Removes fuel inlet filter. Cleans or replaces as necessary.			
4. Installs fuel inlet filter and connects fuel line.			
5. Raises vehicle as necessary.			
6. Removes and checks fuel pump outlet filter.			
7. Cleans or replaces fuel pump outlet filter, and installs.			
8. Lowers vehicle as necessary.			
9. Removes and checks in-line fuel filter.			
10. Cleans or replaces in-line fuel filter and installs.			
11. Installs carburetor air cleaner assembly.			
12. Performs operational test.			
13. Uses proper tools and equipment.			
14. Follows all appropriate safety precautions.			
15. Does performance in an acceptable amount of time.			

SAMPLE

Tools and Equipment

For this objective, you will need to use the tools and equipment listed below. You will be given the procedures for using special tools and equipment as you work through the activities.

Basic Hand Tool Set

Special-Purpose Hand Tools

flare-nut wrench
hose-clamp pliers

Basic Equipment

fender covers
extension light
compressed air hose
compressed air blowgun
hydraulic floor jack
jack stands

Safety Equipment

eye protection

Special Equipment

hydraulic lift

Reading List

If you would like additional information as you work through this performance objective, use the references below.

General References

Crouse, *Automotive Mechanics,* pp. 151-52, 192-93.
Crouse, *The Auto Book,* p. 189.
Ellinger, *Automechanics,* p. 131.
Stockel, *Auto Mechanics Fundamentals,* pp. 123-24.
Stockel, *Auto Service and Repair,* pp. (20-13)-(20-15).
Toboldt and Johnson, *Automotive Encyclopedia,* p. 292.

Special-Purpose References

Ellinger, *Automotive Systems: Fuel, Lubrication, and Cooling,* p. 103.
Crouse, *Automotive Fuel, Lubricating, and Cooling Systems,* pp. 42-43.

Personal and Service Safety Practices

Safety When Using Hydraulic Floor Jacks and Jack Stands

- Never put more weight on hydraulic floor jacks or jack stands than their rated capacities.
- Place the jack securely under the vehicle frame.

- Slowly raise the vehicle with the jack.
- Always support the vehicle by placing the jack stands in a secure position under the vehicle.
- Always place the jack handle in the *up* position. Do not leave it on the floor where a person can trip over it.

Safety When Using Hydraulic Lift Equipment

- Never put more weight on the lift than its rated capacity.
- Never rock the vehicle in any direction while it is on the lift.
- Always be sure the vehicle is securely on the lift before raising the lift.
- Always be sure the safety lock on the lift is engaged after the vehicle has been lifted.

Safety When Working around Fuel

- Never light a match or cigarette, or cause any other spark or flame while you are servicing the fuel system.
- Always clamp flexible fuel lines before disconnecting them. This will keep excess fuel from dripping out when you remove the line.
- Always plug steel fuel lines after disconnecting them. This will keep excess fuel from dripping out.
- Always use the extension light carefully while you are servicing the fuel system. If you drop and break the light, the fuel can ignite and cause an explosion or fire.

Safety When Working with Compressed Air and Blowguns

- Never point a compressed air blowgun at anyone.
- Always control the flow of air. Point it in the right direction and only use as much force as you need for cleaning.
- Only use a compressed air blowgun when its use is recommended with the fuel filter you are working on.

Safety in Work Clothing and Grooming

- Do not wear loosely fitting clothing or loosely hanging long hair—both can get caught in equipment. Wear a hair net or keep your hair under a hat if it is longer than conventional length (over shirt collar).
- Wear eye protection when you work under a vehicle.

Turn to your Review Exercise Book and complete Exercise 5.

REMOVING, INSPECTING, AND INSTALLING OR REPLACING FUEL FILTERS

In the technical service manual, you will find tune-up specifications for a particular vehicle. They will look something like this:

FILTERS AND CLEANERS

Filter or Cleaner	Service Interval (Miles)
Fuel Filter (Carb. Inlet)	②Replace 15,000

②Replace at 30,000 if in-line is also used.

The chart tells you that:

- the vehicle has a fuel filter ("Fuel Filter")
- the filter is on the inlet side of the carburetor ("Carb. Inlet")
- the filter should be replaced every 15,000 miles ("Replace at 15,000")
- the carburetor inlet fuel filter and the in-line filter will probably need to be replaced every 30,000 miles if there is also an in-line filter ("Replace at 30,000").

Each fuel filter described below has a filter element made of ceramic, bronze, or paper. Most elements are made of paper and can simply be replaced. Ceramic and bronze filters are cleaned by blowing compressed air through them. However, they must be replaced when they are too dirty to be cleaned. The fuel filter that is located in the fuel tank cannot be removed and inspected unless the tank is removed. No removal procedures are included here.

Removing and Replacing the Fuel Pump Filter (Outlet Filter)

Figures 24-1 and 24-2 show two different locations of the fuel filter in the pump.

Figure 24-1 Fuel filter on bottom of pump

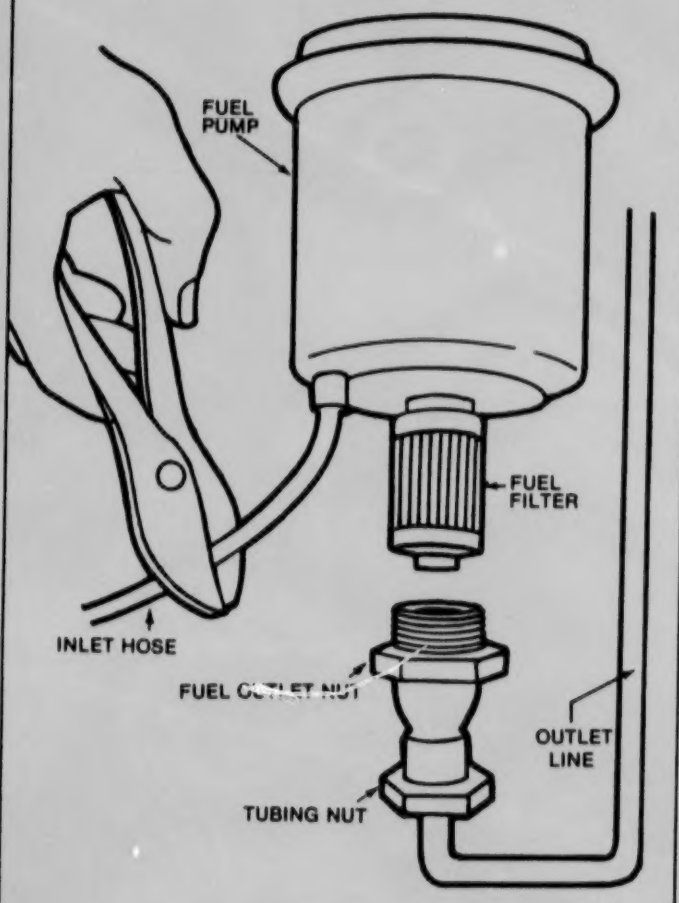
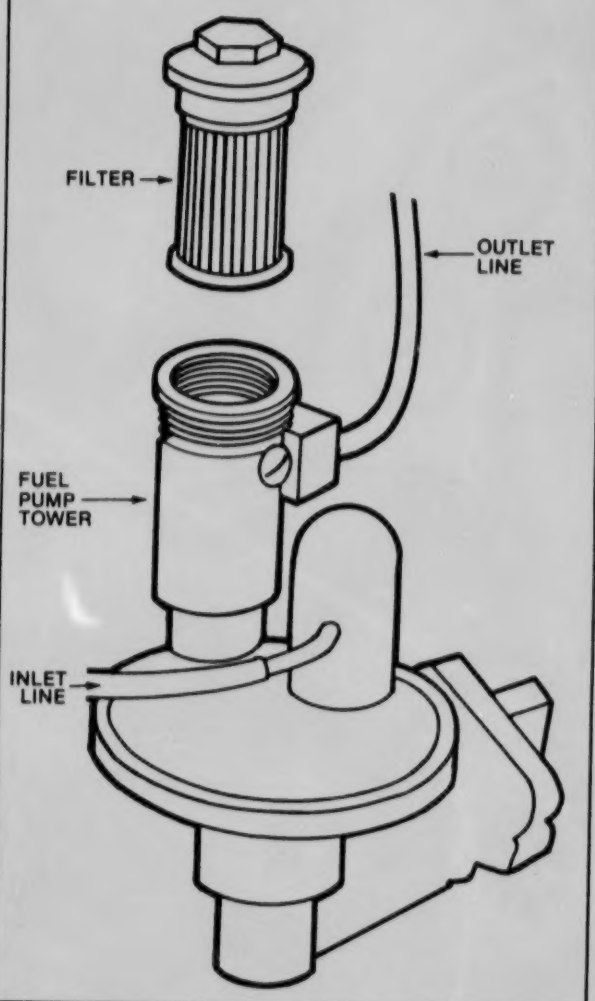


Figure 24-2 Fuel filter on top of pump

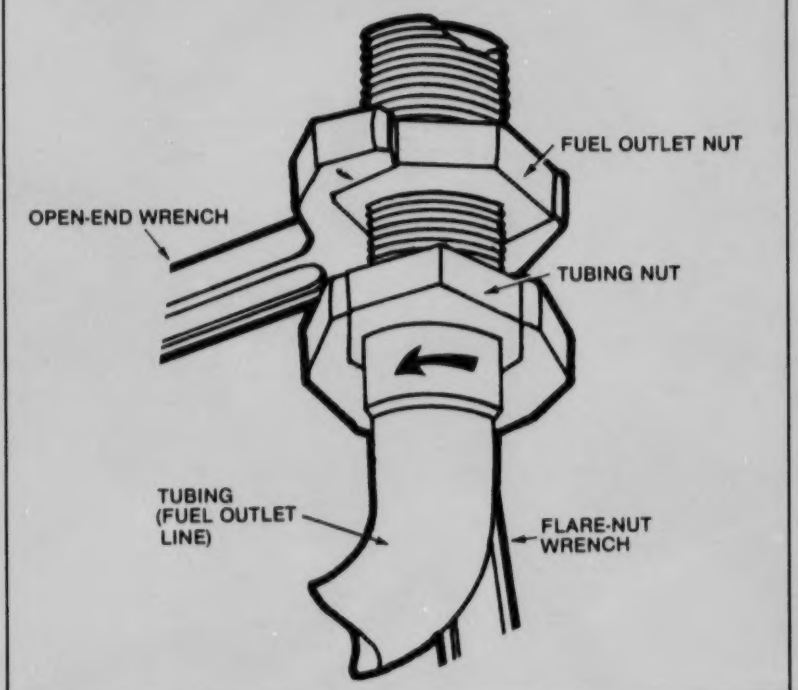


To remove a fuel filter from the bottom of the pump, first raise the vehicle if necesary. Then follow these steps:

STEP 1 Using locking pliers, clamp the flexible hose that leads from the fuel tank to the fuel pump.

STEP 2 Remove the outlet fuel line from the pump. (The outlet line carries fuel from the pump to the carburetor.) Use two wrenches: a flare-nut wrench to turn the tubing nut and an open-end wrench to hold the fuel outlet nut. Both kinds are shown in Figure 24-3.

Figure 24-3 Removing fuel line from bottom of pump



STEP 3 Remove the fuel outlet nut. Collect the washers, springs, and filter element in the order that they come out of the fuel pump.

To replace the filter, reverse the removal procedures. Be sure to follow the manufacturer's directions, which come with the new filter. The filter must be placed in the pump so that the fuel will flow toward the carburetor.

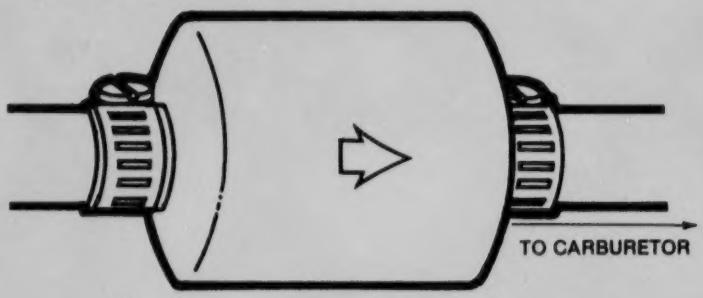
To remove the fuel filter from the fuel pump tower, unscrew the filter. Replace it by screwing the new filter into the tower.

CAUTION: After replacing a fuel pump filter, always run the engine for a few minutes to check for fuel leaks.

Removing and Replacing the Line Filter (In-Line Filter)

Most filters in the fuel lines can be removed, thrown away, and replaced with new ones. They are placed in flexible fuel lines and connected by hose clamps at each end, as shown in Figure 24-4 and 24-5.

Figure 24-4 In-line filter with arrow pointing to carburetor

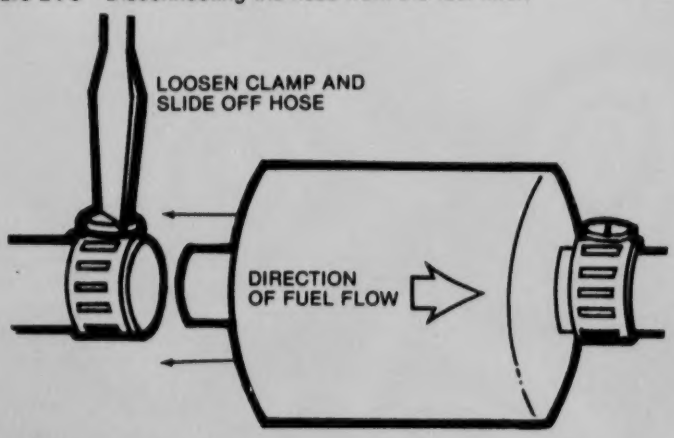


To remove the in-line fuel filter, loosen the hose clamps with a screwdriver (or pliers), and slide each hose off its fitting, as shown in Figure 24-5.

To install the new in-line filter, follow the manufacturer's directions. Place the in-line filter in the fuel line so that the fuel flows to the fuel pump or carburetor.

Install the hoses by clamping them onto the filter fittings. Be sure the clamps are securely in place.

Figure 24-5 Disconnecting the hose from the fuel filter.



CAUTION: DO NOT squeeze the metal container of the filter. It may collapse and damage the internal filter element.

Run the engine for a few minutes to check for fuel leaks.

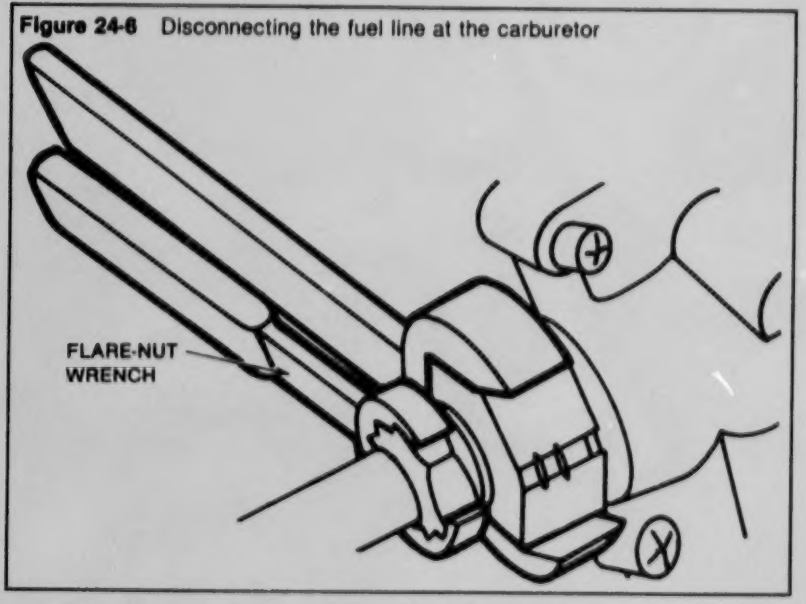
Replacing the Carburetor Inlet Filter

To remove the carburetor inlet filter, you will usually have to remove the carburetor air cleaner (which you learned how to do in Performance Objective 23).

After you remove the carburetor air cleaner, remove the carburetor inlet filter by doing the following:

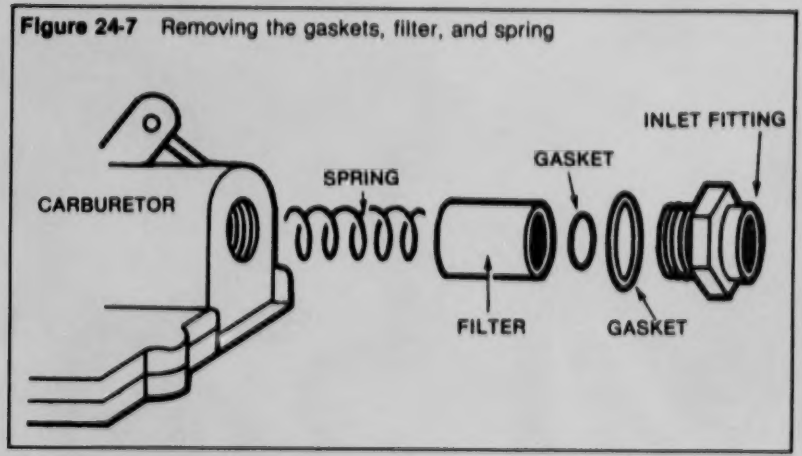
STEP 1 Using a flare-nut wrench, disconnect the fuel line at the carburetor. To do this, hold the carburetor inlet filter nut and turn the fitting, as shown in Figure 24-6.

Figure 24-6 Disconnecting the fuel line at the carburetor



STEP 2 Then remove the gasket(s), filter, and spring, as shown in Figure 24-7.

Figure 24-7 Removing the gaskets, filter, and spring



STEP 3 To replace the filter, follow the directions that come with the filter. Make sure the filter is installed in the correct position, according to the correct direction of flow. Be careful to put all parts back in the right

order. When replacing a filter element, be sure to replace the gaskets.

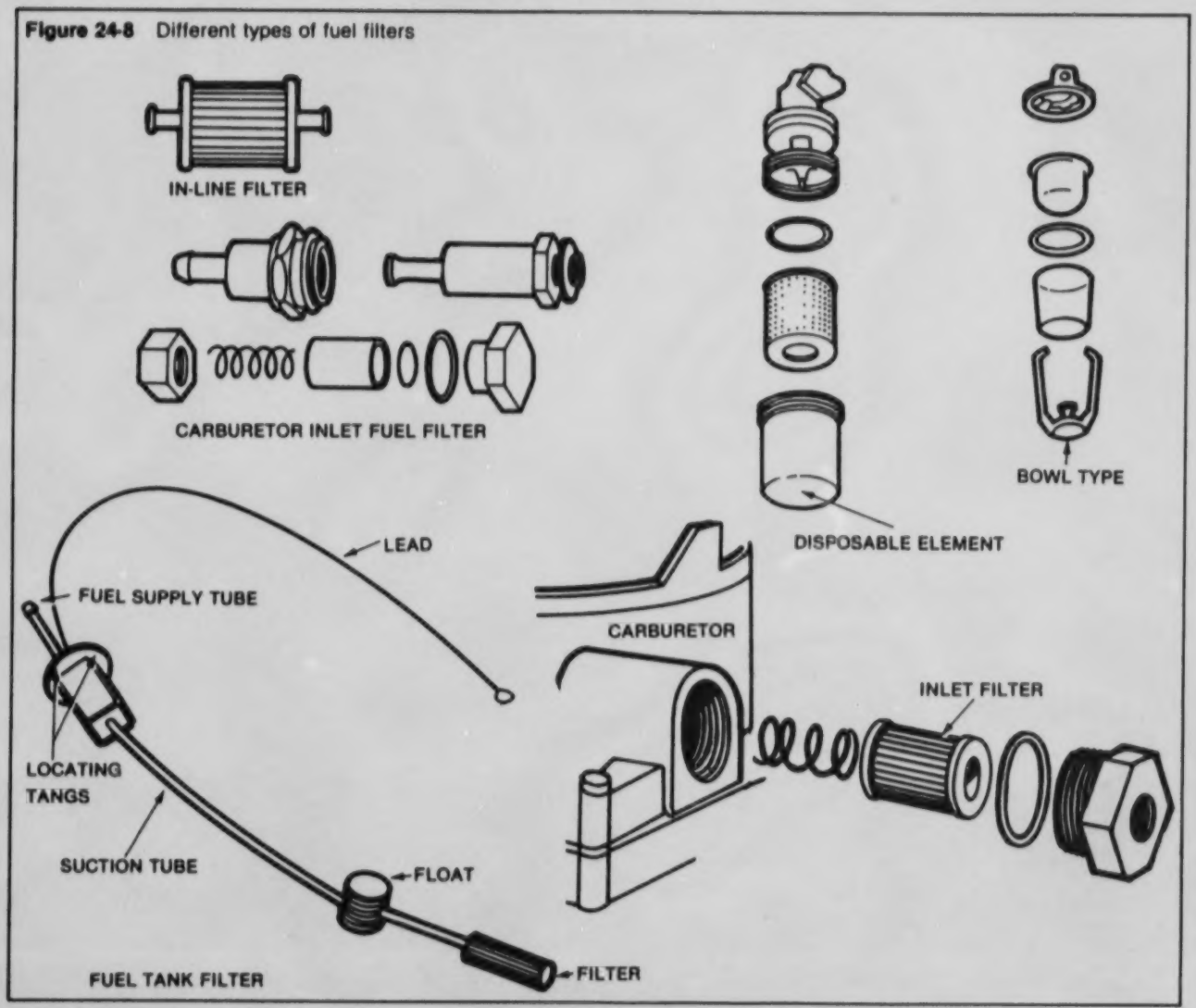
- If the filter is the bronze metal type, be sure the large opening faces the fuel inlet fitting.
- If the filter is the paper type, be sure the gasket end of the filter faces the fuel inlet fitting.

STEP 4 Attach the fuel line at the carburetor.

STEP 5 Start the engine and check for any leaks.

Figure 24-8 shows some of the different types of fuel filters and their connecting parts.

Figure 24-8 Different types of fuel filters



Turn to your Review Exercise Book and complete Exercise 6.

WORK ACTIVITIES

Do not begin any of these work activities until you have your instructor's approval. If you have any difficulty, review the pages listed next to each work activity. If you still have difficulty, ask your instructor for help.

1. Remove and inspect the fuel filter(s) on at least one vehicle. (pages 29-33) *Check your work with your instructor.*

2. Replace (or clean) and install the fuel filter(s) as needed. (pages 29-33) *Check your work with your instructor.*

3. Make an operational check of your work. (pages 29-33) *Check your work with your instructor.*

After you have finished these activities, ask your instructor to return your pretest on Performance Objective 24. Complete the questions that you missed or were unable to answer the first time you took the pretest. Check your answers with your instructor when you finish. Your instructor will then tell you if you are ready to be checked off on the performance checklist or if you need to correct some of your answers first.

If you are told by your instructor that you are ready for the performance checklist, carefully tear the checklist out of your Review Exercise Book and give it to your instructor.

PERFORMANCE OBJECTIVE 25
MEASURE FUEL FLOW AND PRESSURE

INTRODUCTION TO P. O. 25

In this performance objective, you'll learn how to test fuel pump volume and pressure. You'll also learn how to perform the fuel pump vacuum test, a test used to find out if there's a problem in the fuel line or the vacuum pump. You may find it helpful to review the principles of carburetion, which are in the introduction to this unit.

Both fuel flow and pressure are measured with the fuel pump in place. Before you test fuel flow and pressure, check the vehicle you're working on to see if an electrical fuel pump was installed by the owner. Electrical fuel pump testing procedures are not covered in this performance objective. The basic principles are the same, but you will need to refer to the carburetion section of a technical service manual to find out how to test an electrical fuel pump.

After you have finished all the activities for Performance Objective 25, your instructor will use a checklist like the one below to evaluate your work.

Performance Checklist—P. O. 25
The instructor will provide a live vehicle. Measure the fuel flow and pressure. All of the performances below must be accomplished.

Student Performances

1. Removes carburetor air cleaner assembly.
2. Hooks up volume/pressure tester.
3. Tests fuel pump volume and records results.
4. Tests fuel pump pressure and records results.
5. Compares results to manufacturer's specifications, and reports any malfunctions.
6. Tests fuel pump and fuel inlet lines for air leaks, and records results.
7. Removes test equipment and installs carburetor air cleaner assembly.
8. Uses proper tools and equipment.
9. Follows appropriate safety precautions.
10. Does performance in an appropriate amount of time.

Instructor Ratings

Acceptable	Not Acceptable	Omit

SAMPLE

Tools and Equipment

For this objective, you will need to use the tools and equipment listed below. You will be given the procedures for using special tools and equipment as you work through the activities.

Basic Hand Tool Set

Special-Purpose Hand Tools

flare-nut wrench
hose-clamp pliers

Basic Equipment

fender covers
extension light
compressed air hose
compressed air blowgun
hydraulic floor jack
jack stands

Safety Equipment

eye protection

Special Equipment

hydraulic lift
fuel pump tester

Reading List

If you would like additional information as you work through this performance objective, use the references below.

General References

Crouse, *Automotive Mechanics,* p. 423.
Crouse, *The Auto Book,* pp. 353-54.
Ellinger, *Automechanics,* pp. 131-32.
Stockel, *Auto Service and Repair,* pp. (20-4)-(20-7).

Special-Purpose References

Ellinger, *Automotive Systems: Fuel, Lubrication, and Cooling,* p. 103.
Crouse, *Automotive Fuel, Lubricating, and Cooling Systems,* p. 170.

Personal and Service Safety Practices

Safety When Connecting and Disconnecting Fuel Lines

- Use a flare-nut wrench on the fittings so that you will not round off the fitting edges. This is important when you are loosening or tightening a fitting.

- Be sure to match the threads of the fittings squarely when you are trying to connect them. If you cross the threads, the poor connection that results will ruin the fittings. It will also cause a fuel leak.

Safety When Working around Fuel

- Never light a match or cigarette, or cause any other spark or flame while you are servicing the fuel system.
- Always use the extension light carefully while you are servicing the fuel system. If you drop and break the light, the fuel can ignite and cause an explosion or fire.

Safety in Work Clothing and Grooming

- Do not wear loosely fitting clothing or loosely hanging long hair—both can get caught in equipment. If your hair is longer than conventional length (over shirt collar), wear a hair net or keep hair under a hat.

Safety When Using Hydraulic Floor Jacks and Jack Stands

- Never put more weight on hydraulic floor jacks or jack stands than their rated capacities.
- Place the jack securely under the vehicle frame.
- Slowly raise the vehicle with the jack.
- Always support the vehicle by placing jack stands in a secure position under the vehicle.
- Always place the jack handle in the *up* position. Do not leave it on the floor where a person can trip over it.

Safety When Using Hydraulic Lift Equipment

- Never put more weight on the lift than its rated capacity.
- Never rock the vehicle in any direction while it is on the lift.
- Always be sure the vehicle is securely on the lift before raising the lift.
- Always be sure the safety lock on the lift is engaged after the vehicle has been lifted.

MEASURING FUEL FLOW

Before making the fuel pump volume test (fuel flow test), be sure that the fuel tank is at least partially full and that the fuel filter is in good condition.

To measure fuel flow, you will need:

- a fuel pump gauge
- a flexible hose
- a container marked in fluid ounces
- additional T fittings or adapters

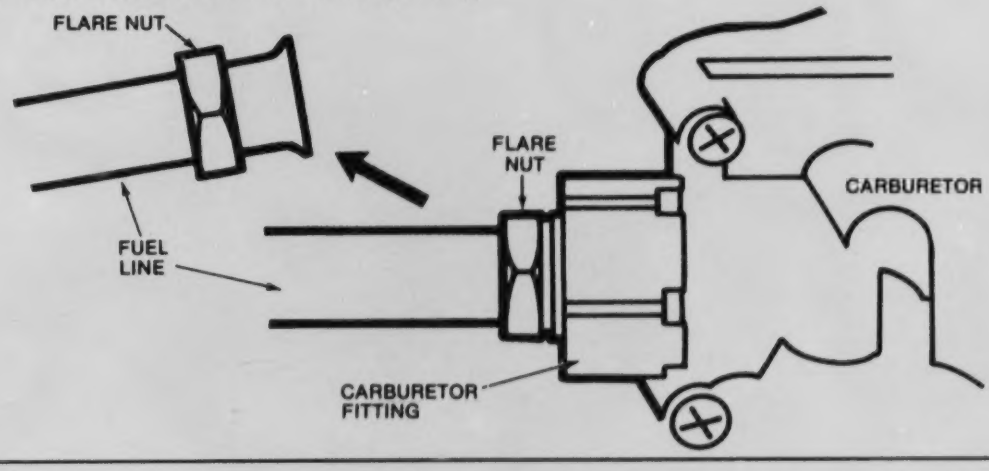
Making the Fuel Pump Volume Test

The fuel pump volume test (fuel flow test) measures the amount of fuel that can flow from the pump to the carburetor in a given amount of time, at a specific engine RPM. The fuel flow or volume test should be made before the pressure test so that the pump can supply full pressure for the pressure test.

To check fuel pump volume:

STEP 1 Disconnect the fuel line from the carburetor fitting, as shown in Figures 25-1 and 25-2.

Figure 25-1 Disconnecting fuel line from carburetor fitting



STEP 2 Install the carburetor adapter fitting to the carburetor fitting, as required.

STEP 3 Connect the fuel pump tester gauge to the carburetor fitting adapter, as shown in Figure 25-3.

STEP 4 Connect the fuel line to the fuel pump tester hose.

STEP 5 Close the clamp on the volume hose.

STEP 6 Put the end of the volume hose into an empty container that has fluid ounces marked on it, as shown in Figure 25-4.

Figure 25-2 Using flare-nut wrench and open-end wrench to disconnect fuel line

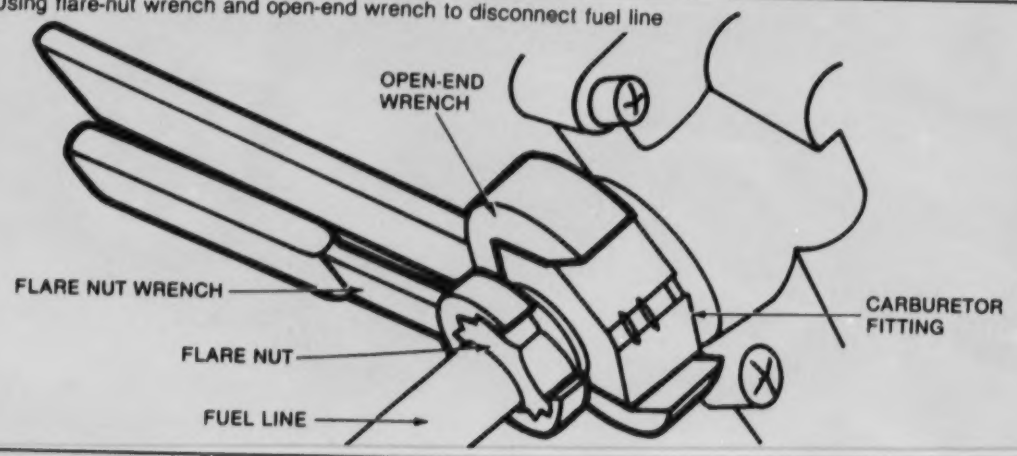


Figure 25-3 Connecting fuel pump tester gauge to carburetor fitting adapter

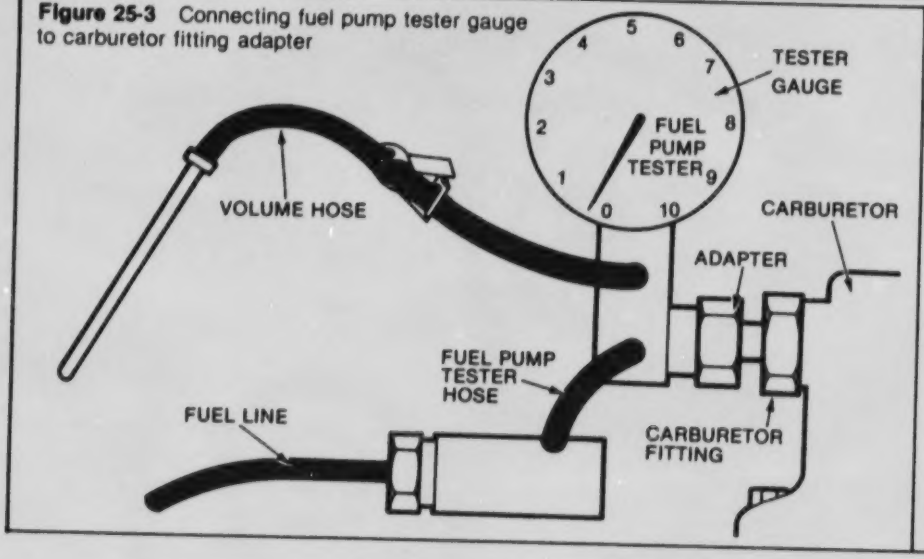
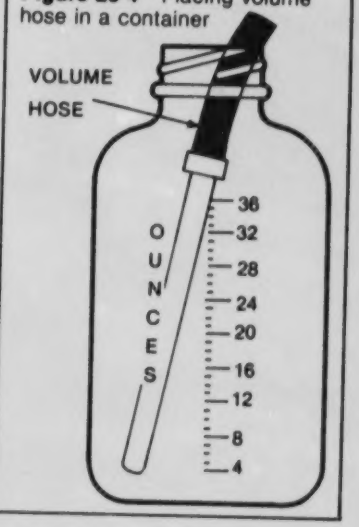


Figure 25-4 Placing volume hose in a container



STEP 7 Connect a tachometer to the ignition system.

STEP 8 Crank the engine and run it at the RPM recommended in the tune-up section of the technical service manual.

STEP 9 Check the tune-up specifications for volume. The specifications tell you how long to let the fuel run into the container, and will look something like this:

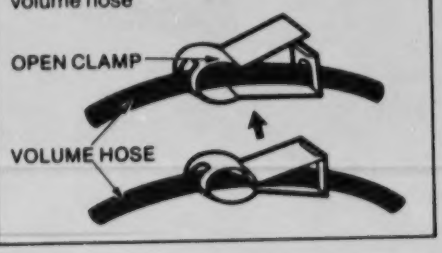
FUEL PUMP

Vehicle model—Make tests at idle RPM

Volume ..... one pint in 30 sec.

This set of specifications tells you that you need to let the fuel flow for 30 seconds. It also tells you that there should be one pint in the container at the end of 30 seconds. Specifications will vary by make and model.

Figure 25-5 Opening the clamp on the volume hose



STEP 10 Once you know how long you must let the fuel flow, open the clamp on the volume hose, as shown in Figure 25-5.

STEP 11 Look at a watch or clock with a second hand for as long as recommended in the manual.

STEP 12 When the recommended amount of time is up, close the clamp on the volume hose and turn off the engine.

STEP 13 Write down the amount of time you let the fuel flow into the container. Next to the time, write down the amount of fuel in the container.

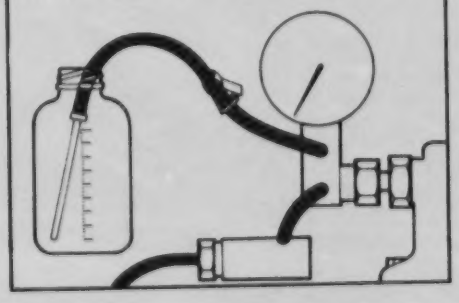
STEP 14 Compare your results to the specifications. If the fuel flow matches the specifications, record the fuel flow as ***good.***

CAUTION: If excessive air bubbles appear in the fuel while it is flowing into the container, you should check for air leaks in the fuel line. You will learn how to do this in the next performance objective.

Keep your notes so that you can use them again when you finish the fuel pump pressure test. Do not change the hookup of the hoses if you are using this equipment, since the same equipment and arrangement of equipment are needed for the pressure test.

Turn to your Review Exercise Book and complete Exercise 7.

Figure 25-6 Setup for fuel pump pressure test (same as volume test)



After doing the volume test to determine fuel flow, use the same setup to test fuel pump pressure, as shown in Figure 25-6.

If your equipment is different from the equipment shown in Figure 25-6, check with your instructor on how to do this test.

Making the Fuel Pump Pressure Test

STEP 1 Check the tune-up specifications for the pressure test in the technical service manual. They will look something like the sample on the following page:

FUEL PUMP	
Pressure	3 lbs. at 500-1000 RPM
Make all tests at idle speed	
Pressure	3-4 psi

The first set of specifications tells you to set the engine speed at somewhere between 500 and 1,000 RPM. At this speed, the needle on the pressure gauge should read *3*.

The second set of specifications tells you to run the engine at idle RPM. You will need to check the manual to find out what the idle RPM is for this vehicle. The specifications also tell you that the pressure reading for this vehicle should be from 3 to 4 psi.

STEP 2 Start the engine and run it at the RPM specified in the manual.

STEP 3 Check the reading on the gauge and write it down underneath your notes on the volume test. Then turn off the engine. Your notes may look something like this:

VOLUME TEST . . . . . 16 oz. in 30 seconds—Good

PRESSURE TEST. . . . . 4 lbs at 1,000 RPM—Good

STEP 4 Compare the results of the pressure test with the specifications. Determine if the pressure is correct.

Interpreting Volume and Pressure Test Results

The results of the fuel pump and volume tests will tell you whether you need to replace the fuel pump. Use this list as a guide.

RESULTS	ACTION NEEDED
a. Volume, Good; Pressure, Low	a. Replace the fuel pump.
b. Volume, Low; Pressure, Good	b. Check the fuel pump inlet fuel lines for restriction or air leaks, or replace the fuel pump.
c. Volume, Low; Pressure, Low	c. Check the fuel pump inlet fuel lines for restriction or air leaks, or replace the fuel pump.
d. Excessive air bubbles in fuel	d. There is an air leak in the fuel line between the pump and the fuel tank. You need to find the leak.

Turn to your Review Exercise Book and complete Exercise 8.

WORK ACTIVITIES

Do not begin any of these work activities until you have your instructor's approval. If you have any difficulty, review the pages listed next to each work activity. If you still have difficulty, ask your instructor for help.

1. Test the fuel pump for volume (fuel flow) and compare your test results to the vehicle manufacturer's specifications. (pages 40-42) *Check your work with your instructor.*

2. Test the fuel pump for pressure and compare your test results to the vehicle manufacturer's specifications. (pages 42-44) *Check your work with your instructor.*

After you have finished these activities, go on the the next section.

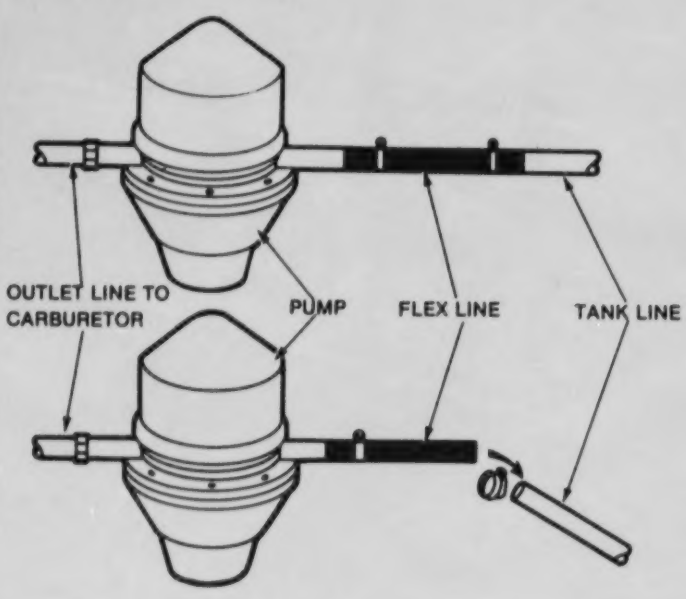
Making the Vacuum Test

The fuel pump vacuum test should be made whenever the fuel pump pressure and volume test results do not meet the vehicle manufacturer's specifications. This test is used to find out whether the problem is in the fuel line or the fuel pump. You should not replace the fuel pump until you have the results of the fuel pump vacuum test to confirm the location of the problem.

The carburetion section of a technical service manual will tell you how to do a vacuum test for a particular type of fuel pump. But as a general guide, you should follow the steps listed below.

STEP 1 Disconnect the fuel pump flexible fuel inlet line (flex line) from the tank fuel line, as shown in Figure 25-7.

Figure 25-7 Flex line location



STEP 2 Connect the vacuum gauge to the flex line. Be sure to use the proper adapter, as shown in Figure 25-8.

STEP 3 Run the engine at idle RPM long enough for the vacuum gauge to reach its highest reading. Then stop the engine.

STEP 4 If the reading is between 10 and 15 inches on the gauge, then the fuel pump valves, flex line, and fuel filter gaskets do not have any air leaks. If the reading is less than 10 inches, test the fuel pump.

Figure 25-8 Connecting the vacuum gauge to the flex line

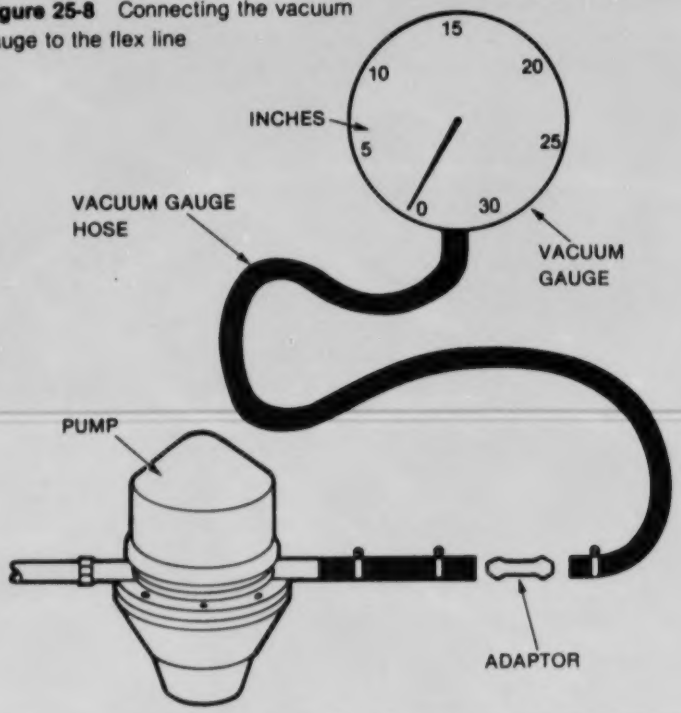
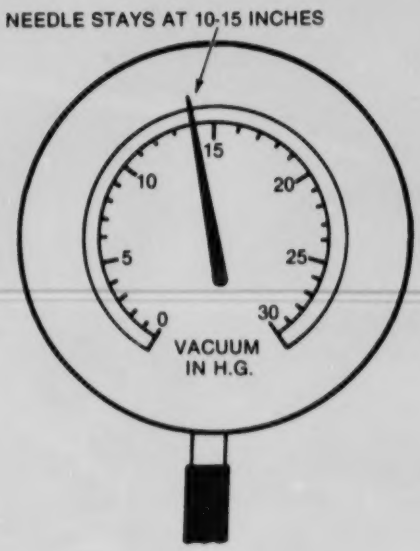
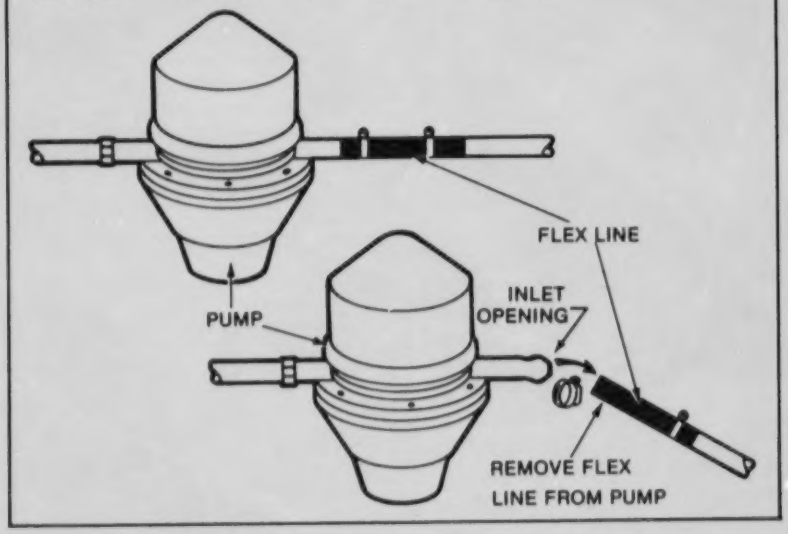


Figure 25-9 Vacuum gauge reads 14 inches



STEP 5 To test the fuel pump, remove the flex line from the fuel pump and connect the vacuum gauge directly to the inlet opening of the pump, as shown in Figure 25-10.

Figure 25-10 Disconnecting flex line at inlet opening



If the reading is still low, the pump must be replaced. (You will learn how to replace the pump in Performance Objective 27.) If the reading is not low, the flex line must be replaced.

STEP 6 To check the entire fuel line (from the fuel tank to the pump) for air leaks, use the vacuum gauge and do the following:

- Disconnect the vacuum gauge and reconnect the flex line to the fuel pump.
- Disconnect the fuel line from the fuel tank. To do this, you'll need to lift the vehicle. Connect the vacuum gauge to the fuel line and run the engine at idle RPM to repeat the vacuum test. Then stop the engine.
- If the vacuum gauge reading drops quickly, then there is an air leak in the line somewhere between the tank and the fuel pump. The line will need to be repaired or replaced as described in Performance Objective 26.

Turn to your Review Exercise Book and complete Exercise 9

WORK ACTIVITY

Do not begin this work activity until you have your instructor's approval. If you have any difficulty, review the pages listed next to the work activity. If you still have difficulty, ask your instructor for help.

3. Test the fuel pump and fuel pump inlet lines for air leaks. Record your results for each test. You should have at least three readings for this work activity. (pages 45-47) *Check your work with your instructor.*

After you have finished this activity, ask your instructor to return your pretest on Performance Objective 25. Complete the questions that you missed or were unable to answer the first time you took the pretest. Check your answers with your instructor when you finish. Your instructor will then tell you if you are ready to be checked off on the performance checklist or if you need to correct some of your answers first.

If you are told by your instructor that you are ready for the performance checklist, carefully tear the checklist out of your Review Exercise Book and give it to your instructor.

PERFORMANCE OBJECTIVE 26

REMOVE, REPAIR, AND INSTALL FUEL LINES

INTRODUCTION TO P. O. 26

A major tune-up includes visual inspection of the fuel lines and hoses, and repair or replacement of them as needed. You will find out how to do this in Performance Objective 26.

After you have finished all the activities for Performance Objective 26, your instructor will use a checklist like the one below to evaluate your work.

PERFORMANCE CHECKLIST—P. O. 26

The instructor will provide either a live vehicle or shop vehicle. Remove and repair or replace any defective fuel lines on the vehicle. All of the performances below must be accomplished.

Student Performances	Instructor Ratings		
	Acceptable	Not Acceptable	Omit
1. Raises vehicle as necessary.			
2. Inspects all fuel lines and hoses.			
3. Repairs or replaces defective sections as necessary.			
4. Lowers vehicle as necessary.			
5. Makes operational checks of fuel lines and hoses.			
6. Uses proper tools and equipment.			
7. Follows all appropriate safety precautions.			
8. Does performance in an acceptable amount of time.			

SAMPLE

Tools and Equipment

For this objective, you will need to use the tools and equipment listed below. You will be given the procedures for using special tools and equipment as you work through the activities.

Basic Hand Tool Set

Special-Purpose Hand Tools

flare-nut wrench
metal tube cutter

Basic Equipment

fender covers
extension light
hydraulic jack
jack stands
steel tube flaring kit
tube bender

Safety Equipment

eye protection

Special Equipment

hydraulic lift

Reading List

If you would like additional information as you work through this performance objective, use the references below.

General References

Crouse, *Automotive Mechanics,* pp. 152, 156.
Stockel, *Auto Mechanics Fundamentals,* pp. 116, 126.
Stockel, *Auto Service and Repair,* pp. (5-1)-(5-19), (20-3).

Special-Purpose Reference

Crouse and Anglin, *Automotive Fuel, Lubrication, and Cooling Systems,* p. 189.

Personal and Service Safety Practices

Safety When Connecting and Disconnecting Fuel Lines

- Use a flare-nut wrench on the fittings so that you will not round off the fitting edges. This is important when you are loosening or tightening a fitting.
- Be sure to match the threads of the fittings squarely when you are trying to connect them. If you cross the threads, the poor connection that results will ruin the fittings. It will also cause a fuel leak.

- Always use fender covers when doing work under the hood. This will keep fenders from getting scratched.
- Always wear eye protection when working under the vehicle.

Safety When Working around Fuel

- Never light a match or cigarette, or cause any other spark or flame while you are servicing the fuel system.
- Always use the extension light carefully while you are servicing the fuel system. If you drop and break the light, the fuel can ignite and cause an explosion or fire.
- Always remove the filter tank pressure caps before disconnecting the fuel lines.

Safety in Work Clothing and Grooming

- Do not wear loosely fitting clothing or loosely hanging long hair—both can get caught in equipment. If your hair is longer than conventional length (over shirt collar), wear a hair net or keep hair under a hat.

Safety When Using Hydraulic Floor Jacks and Jack Stands

- Never put more weight on hydraulic floor jacks or jack stands than their rated capacities.
- Place the jack securely under the vehicle frame.
- Slowly raise the vehicle with the jack.
- Always support the vehicle by placing jack stands in a secure position under the vehicle.
- Always place the jack handle in the *up* position. Do not leave it on the floor where a person can trip over it.

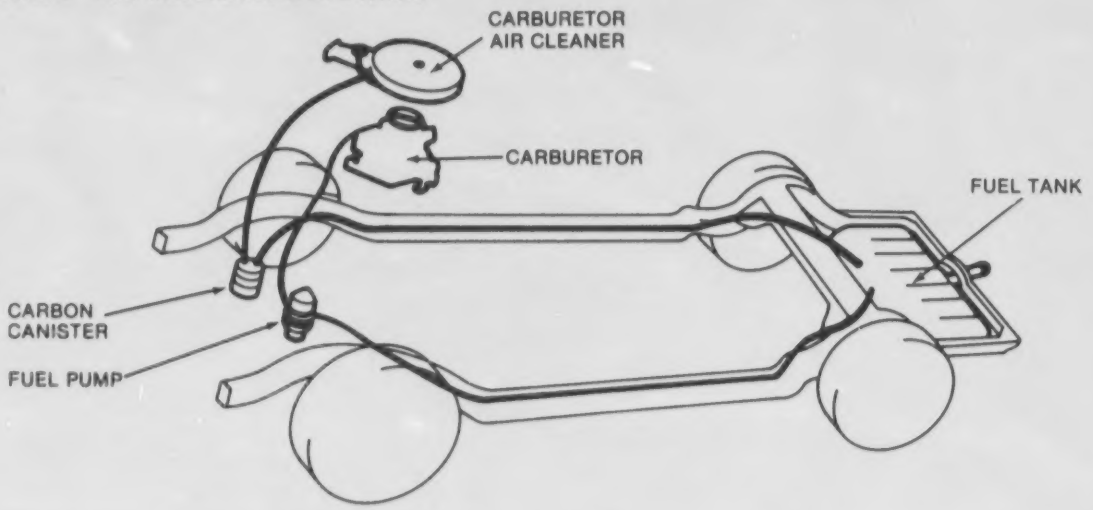
Safety When Using Hydraulic Lift Equipment

- Never put more weight on the lift than its rated capacity.
- Never rock the vehicle in any direction while it is on the lift.
- Always be sure the vehicle is securely on the lift before raising the lift.
- Always be sure the safety lock on the lift is engaged after the vehicle has been lifted.

INSPECTING FUEL LINES AND HOSES

A fuel line or hose extends from the tank to the fuel pump and from the pump to the carburetor. A fuel line or hose also extends from the carburetor to a carbon canister, from the canister to the tank, and/or from the canister to the air cleaner, as shown in Figure 26-1.

Figure 26-1 Fuel lines and hoses on a vehicle



Any of these lines or hoses can become cracked, pinched, broken, or blocked.

To inspect the fuel lines or hoses properly, raise the vehicle on a lift and check all the lines or hoses under the vehicle. Also, be sure to check all the lines and hoses under the hood after you lower the vehicle.

Turn to your Review Exercise Book and complete Exercise 10.

WORK ACTIVITY

Do not begin this work activity until you have your instructor's approval. If you have any difficulty, review the pages listed next to the work activity. If you still have difficulty, ask your instructor for help.

1. Inspect the fuel lines and/or hoses on a vehicle and list the visible defects. (pages 53-54) *Check your work with your instructor.*

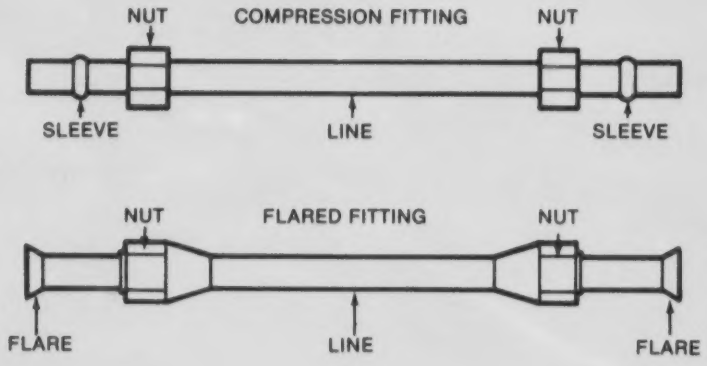
After you have finished this work activity, go on to the next section.

REMOVING, REPAIRING, AND INSTALLING FUEL LINES AND HOSES

Removing and Repairing Rigid Fuel Lines

Fuel lines will usually have one of the fittings shown in Figure 26-2 at each end.

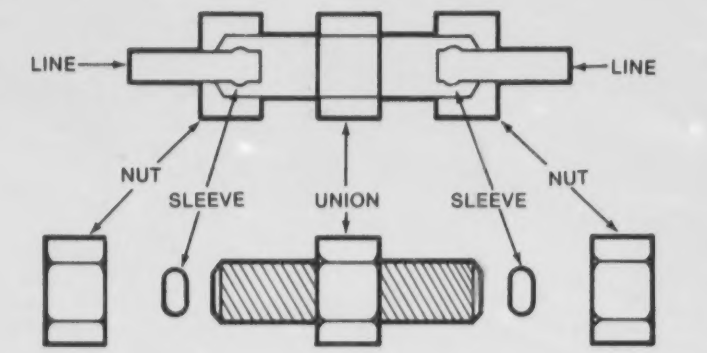
Figure 26-2 Typical fuel line fittings



The ***sleeve*** on the compressed fitting and the ***flare*** on the flared fitting may fit into ***unions*** on other parts of the vehicle. Look at Figure 26-3. Unions are pieces that connect the fitting at one end of the line to the fitting (nut) at the end of another line. A union comes assembled with two nuts and two sleeves.

NOTE: The figure may have a flare or a sleeve, as shown in Figure 26-2.

Figure 26-3 A union connecting two fuel lines



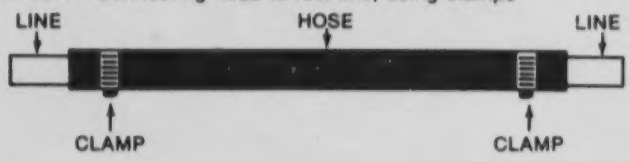
STEP 1 When removing rigid fuel lines, you may need to slip or pull the lines from spring-loaded clamps that hold the lines in place (see Figure 26-4).

STEP 2 After you remove the defective line, cut out the defective part with a tubing cutter.

STEP 3 Use a fine file to clean burrs off the cut ends.

STEP 4 If the line is in the engine compartment, cut a section of neoprene tubing (fuel hose) and clamp each end of the tubing to the cut edge of the line, as shown in Figure 26-4.

Figure 26-4 Connecting hose to fuel line, using clamps

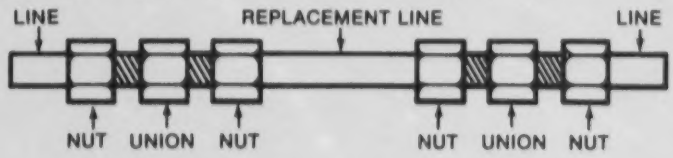


Although it's okay to use neoprene tubing to replace a part of a fuel line in the engine compartment, it's unsafe to use a neoprene line to replace a line under the vehicle (it will not hold up to the wear and tear under the vehicle).

STEP 5 To replace the defective line under the vehicle, do the following:

a. Use a fine file to clean the burrs off each cut end.
b. Slide a nut onto each cut end.
c. Slide a sleeve onto each cut end.
d. Connect each completed nut, sleeve, and tubing assembly to the union, as shown in Figures 23-3 and 23-5.

Figure 26-5 A typical replacement line under the vehicle



Whenever you use rigid tubing to replace part or all of a fuel line, be sure to use only the type of tubing that is appropriate for the line. For example, steel tubing should be used only on steel lines. Never use copper tubing since it is too soft to withstand the treatment that lines usually receive underneath the vehicle.

When installing rigid tubing, you may also need a tube bender to shape bends into the line. ***All bends should be smooth.*** Be sure to use the correct size of tubing for the line.

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Removing Flexible Fuel Lines (Hoses)

STEP 1 First remove the steel clamp from each end of the hose and/or loosen each end of the hose from the fitting.

- If a fuel hose is defective, it cannot be repaired. The whole hose must be replaced.
- Always use a neoprene hose for fuel lines. Gasoline will deteriorate the rubber tubing.

STEP 2 When replacing the neoprene fuel hose, use stainless steel clamps for connecting each end of the hose to a fitting.

STEP 3 Start the engine and check for leaks in the connections and hoses.

NOTE: You may also need to repeat the fuel pump volume and pressure tests presented in Performance Objective 25.

Turn to your Review Exercise Book and complete Exercise 11.

WORK ACTIVITIES

Do not begin any of these activities until you have your instructor's approval. If you have any difficulty, review the pages listed next to each work activity. If you still have difficulty, ask your instructor for help.

2. Remove at least one defective fuel line and/or hose from a vehicle. (pages 54-55) *Check your work with your instructor.*

3. Repair at least one defective fuel line, using the correct tools and materials. (pages 55-57) *Check your work with your instructor.*

4. Install (or replace) at least one fuel line or hose on a given vehicle. (pages 56-57) *Check your work with your instructor.*

5. Make an operational check of your work on the fuel line and/or hose. (pages 54-57) *Check your work with your instructor.*

After you have finished these activities, ask your instructor to return your pretest on Performance Objective 26. Complete the questions that you missed or were unable to answer the first time you took the pretest. Check your answers with your instructor when you finish. Your instructor will then tell you if you are ready to be checked off on the performance checklist or if you need to correct some of your answers first.

If you are told by your instructor that you are ready for the performance checklist, carefully tear the checklist out of your Review Exercise Book and give it to your instructor.

PERFORMANCE OBJECTIVE 27
REMOVE OR REPLACE THE FUEL PUMP

INTRODUCTION TO P. O. 27

Replacing a fuel pump is easier and less expensive than overhauling or repairing a bad one. Some pumps are sealed units. When these units no longer operate well, they must be replaced—they cannot be repaired. The most common type of fuel pump is the mechanical-diaphragm pump. Another common type is the electric fuel pump.

In this performance objective, you'll learn how to replace a mechanical fuel pump. Follow the instructions in a technical service manual when replacing an electric pump.

After you have finished all the activities for Performance Objective 27, your instructor will use a checklist like the one below to evaluate your work.

PERFORMANCE CHECKLIST—P.O. 27

The instructor will provide either a live vehicle or live engine. Remove and replace the mechanical fuel pump. All of the performances below must be accomplished.

Student Performances	Instructor Ratings		
	Acceptable	Not Acceptable	Omit
1. Raises vehicle as necessary.			
2. Disconnects fuel lines from fuel pump.			
3. Removes fuel pump mounting bolts and fuel pump.			
4. Installs new fuel pump mounting gasket on replacement pump.			
5. Installs replacement pump.			
6. Connects fuel lines.			
7. Lowers vehicle as necessary.			
8. Makes operational check of fuel pump.			
9. Uses proper tools and equipment.			
10. Follows all appropriate safety precautions.			
11. Does performance in an acceptable amount of time.			

SAMPLE

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Tools and Equipment

For this objective, you will need to use the tools and equipment listed below. You will be given the procedures for using special tools and equipment as you work through the activities.

Basic Hand Tool Set

Special-Purpose Hand Tool

flare-nut wrench

Basic Equipment

fender covers
extension light
hydraulic jack
jack stands

Special Equipment

hydraulic lift

Reading List

If you would like additional information as you work through this performance objective, use the references below.

General References

Crouse, *Automotive Mechanics,* pp. 153-57.
Crouse, *The Auto Book,* pp. 189, 191, 194.
Ellinger, *Automechanics,* pp. 129-31.
Stockel, *Auto Mechanics Fundamentals,* pp. 119-27.
Stockel, *Auto Service and Repair,* pp. (20-4)-(20-15).
Toboldt and Johnson, *Automotive Encyclopedia,* pp. 283-87.

Special-Purpose Reference

Crouse and Anglin, *Automotive Fuel, Lubricating, and Cooling Systems,* pp. 45-49, 190-192.

Personal and Service Safety Practices

Safety When Using Hydraulic Floor Jacks and Jack Stands

- Never put more weight on hydraulic floor jacks or jack stands then their rated capacities.
- Place the jack securely under the vehicle frame.
- Slowly raise the vehicle with the jack.
- Always support the vehicle by placing jack stands in a secure position under the vehicle.
- Always place the jack handle in the *up* position. Do not leave it on the floor where a person can trip over it.

Safety When Using Hydraulic Lift Equipment

- Never put more weight on the lift than its rated capacity.
- Never rock the vehicle in any direction while it is on the lift.
- Always be sure the vehicle is securely on the lift before raising the lift.
- Always be sure the safety lock on the lift is engaged after the vehicle has been lifted.

Safety When Connecting and Disconnecting Fuel Lines

- Use a flare-nut wrench on the fittings so that you will not round off the fitting edges. This is important when you are loosening or tightening a fitting.
- Be sure to match the threads of the fittings squarely when you are trying to connect them. If you cross the threads, the poor connection that results will ruin the fittings. It will also cause a fuel leak.

Safety When Working around Fuel

- Never light a match or cigarette, or cause any other spark or flame while you are servicing the fuel system.
- Always remove the filler tank pressure caps before disconnecting the fuel lines.
- Always clamp flexible fuel lines before disconnecting them. This will keep excess fuel from dripping out when you remove the line.
- Always plug steel fuel lines after disconnecting them. This will keep excess fuel from dripping out.
- Always use the extension light carefully while you are servicing the fuel system. If you drop and break the light, the fuel can ignite and cause an explosion or fire.

Safety When Working with an Electric Fuel Pump

- Double-check to be sure the ignition switch is *off*.
- Be sure to disconnect the battery before working with an electric fuel pump. (You'll find other precautions and directions in a technical service manual.)

Safety in Work Clothing and Grooming

- Do not wear loosely fitting clothing or loosely hanging long hair—both can get caught in equipment. Wear a hair net or keep your hair under a hat if it is longer than conventional length (over shirt collar).
- Wear eye protection whenever you work under a vehicle.

Turn to your Reveiw Exercise Book and complete Exercise 12.

C1

REMOVING A MECHANICAL FUEL PUMP

- Fuel pumps are mounted in several locations on vehicles, depending on the vehicle make and model and on the size of the engine. For example, the fuel pump location on a V-8 engine and a V-6 engine may differ, as shown in Figures 27-1 and 27-2.

Figure 27-1 Fuel pump location on a V-8 engine

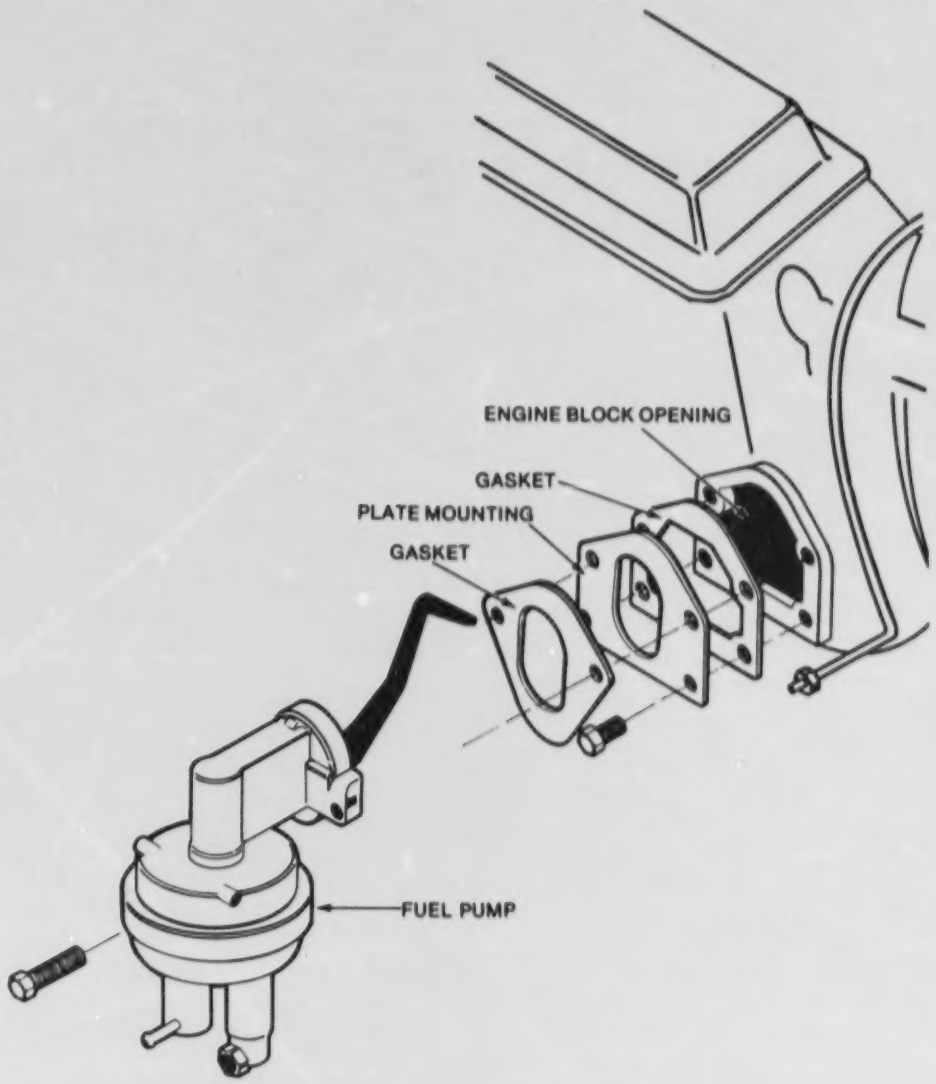
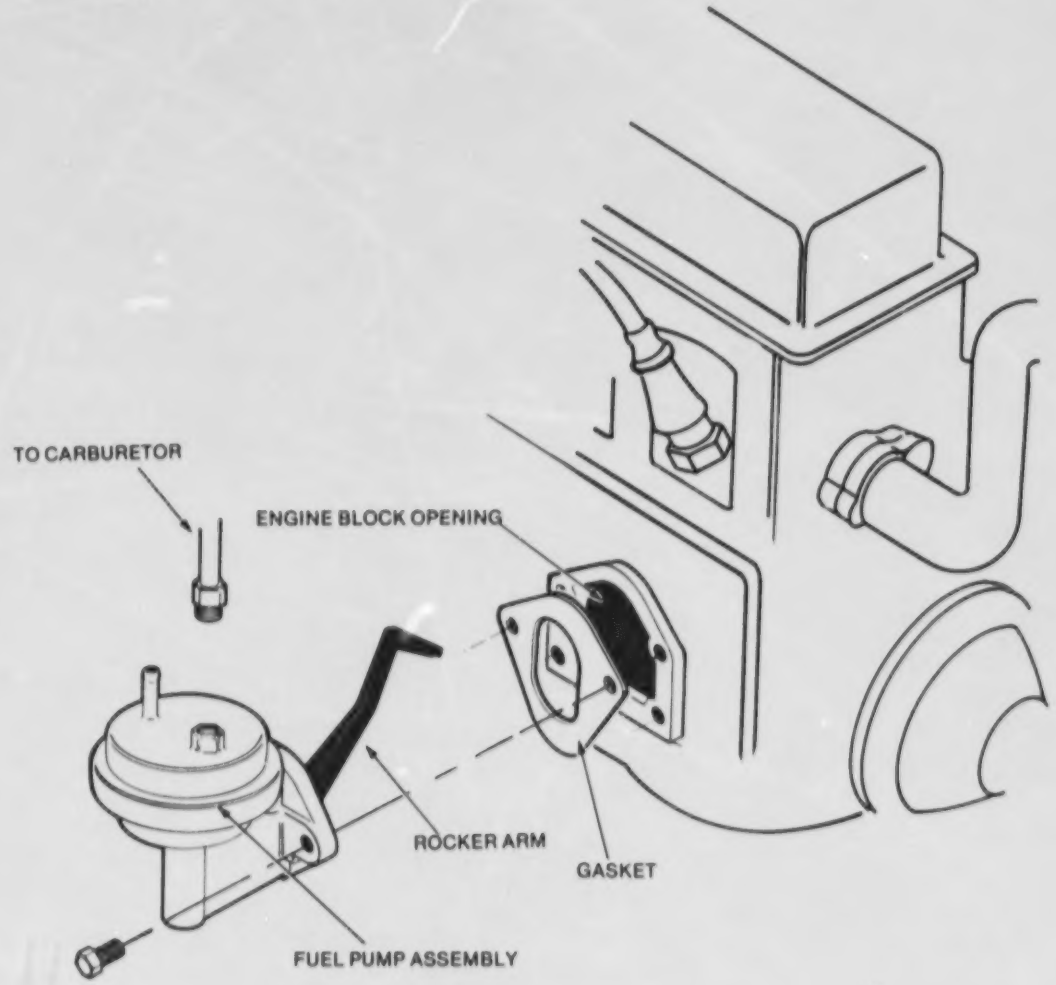


Figure 27-2 Fuel pump location on a V-6 engine



Be sure to remember the position of the rocker arm (see Figure 27-2) when removing the fuel pump. You will need this information when you get ready to install the fuel pump.

Here are the basic steps for removing a mechanical fuel pump.

STEP 1 Wipe off any dirt and grease from the pump and the engine mounting. This will keep dirt from falling into the engine.

STEP 2 If a heat shield is used on the vehicle, be sure to remove it.

STEP 3 Disconnect the fuel lines from the pump. (Remember to clamp or plug the lines as needed.)

STEP 4 Remove the nuts or bolts and lockwashers from the mounting pad on the engine block.

STEP 5 Lift off the pump by working it ***gently*** from side to side, or slide a pry bar under the mounting flange and ***gently*** pry the pump loose. (Be careful not to damage the flange or the connecting studs.)

STEP 6 As you remove the fuel pump, make a note of the position of the rocker arm.

STEP 7 If a pushrod (see Figure 27-2) is present, be sure to remove it by pulling it straight out. Then examine the pushrod for wear and for sticking. If one end looks as though it's worn (if it is concave or curved in), then you may need to get a new pushrod to fit into the engine block.

STEP 8 Finally, be sure to scrape the old gasket from the engine block.

Turn to your Review Exercise Book and complete Exercise 13.

WORK ACTIVITY

Do not begin this work activity until you have your instructor's approval. If you have any difficulty, review the pages listed next to the work activity. If you still have difficulty, ask your instructor for help.

1. Remove a mechanical fuel pump from a vehicle. (pages 65-67) ***Check your work with your instructor.***

After you have finished this activity, go on to the next section.

REPLACING A MECHANICAL FUEL PUMP

When you are replacing a defective fuel pump, compare the new pump to the old one to see if they look the same. Also, check the parts listing to be sure you have the right part number for the vehicle year, make, and model.

Here are the steps for the most common method of installing a mechanical fuel pump. Before you begin installing the pump, you should:

- be sure the fuel lines and connections are in good condition
- coat any new gaskets with sealant.

STEP 1 Clean the engine mounting surface.

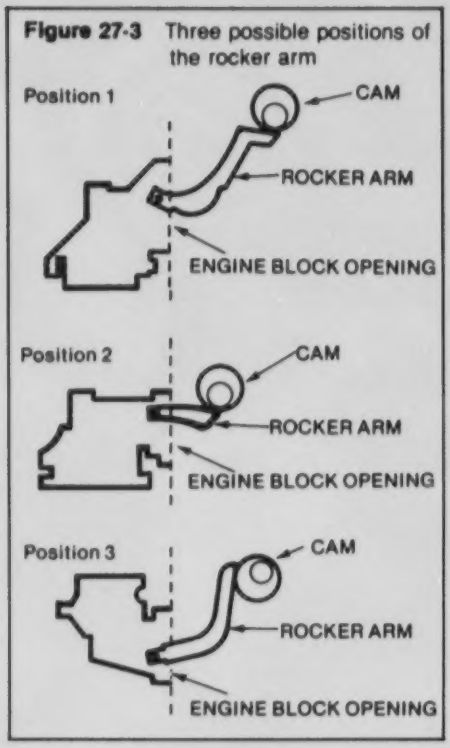


Figure 27-3 Three possible positions of the rocker arm

STEP 2 Install a new gasket on the mounting plate. Then put the other new gasket on the fuel pump mounting (or over the engine block opening).

STEP 3 Put the rocker arm of the fuel pump into the engine block opening in the correct position. Be sure the arm is on the proper side of the camshaft, or center it over the pushrod. Figure 27-3 shows some of the possible positions.

Be sure the rocker arm is against the cam when you're installing the fuel pump. You won't be able to see the cam, but you can feel the pressure of the rocker arm against the cam. Figure 27-3 shows you where you should feel the pressure against the cam. Ask your instructor for help if you have trouble.

STEP 4 Align the holes in the fuel pump flange with the holes around the engine block opening. (If this is too hard to do, you may need to turn the engine over until the fuel pump rocker arm is in the right position against the cam. You can do this by bumping the engine with a remote starter switch.)

STEP 5 When installing a fuel pump with a pushrod, you may need the help of some mechanical fingers (if you have room for using them). These fingers can hold the pushrod up while you are placing the pump in the correct position.

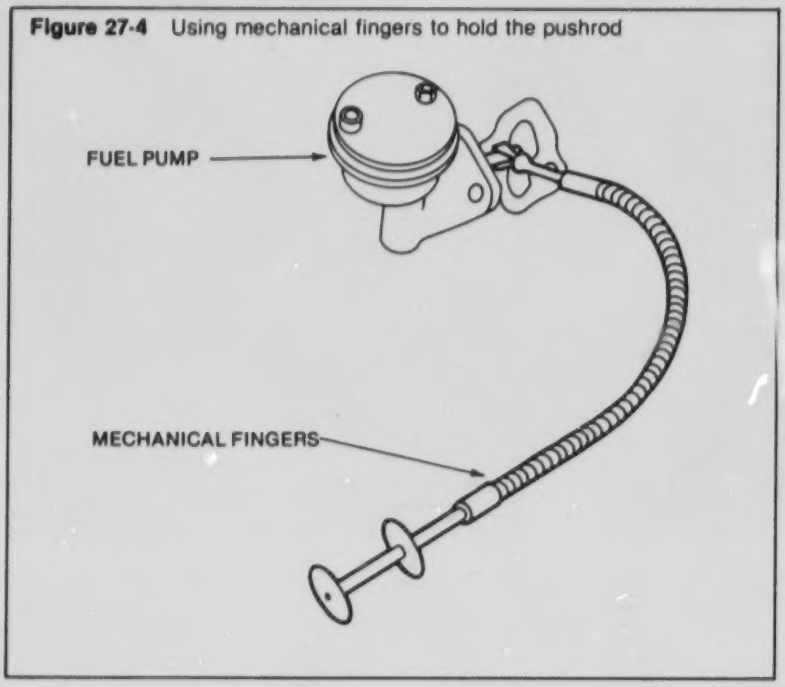


Figure 27-4 Using mechanical fingers to hold the pushrod

STEP 6 Secure the fuel pump in its correct position by reinstalling the nuts or bolts and the lockwashers.

STEP 7 Reconnect the fuel lines and be sure the connections are secure.

STEP 8 Check the operation of the fuel pump by running the engine and checking for fuel leaks.

Turn to your Review Exercise Book and complete Exercise 14.

WORK ACTIVITIES

Do not begin any of these work activities until you have your instructor's approval. If you have any difficulty, review the pages listed next to each work activity. If you still have difficulty, ask your instructor for help.

2. Install a mechanical fuel pump in a vehicle. (pages 67-69) *Check your work with your instructor.*

3. Make an operational check of the mechanical fuel pump. (page 69) *Check your work with your instructor.*

After you have finished these activities, ask your instructor to return your pretest on Performance Objective 27. Complete the questions that you missed or were unable to answer the first time you took the pretest. Check your answers with your instructor when you finish. Your instructor will then tell you if you are ready to be checked off on the performance checklist or if you need to correct some of your answers first.

If you are told by your instructor that you are ready for the performance checklist, carefully tear the checklist out of your Review Exercise Book and give it to your instructor.

PERFORMANCE OBJECTIVE 28

ADJUST CARBURETOR IDLE MIXTURE AND IDLE SPEED

INTRODUCTION TO P.O. 28

This performance objective focuses on carburetor idle and mixture adjustments, both of which directly relate to the fuel system. You will find out how to adjust the carburetor idle mixture and idle speed to manufacturer's specifications. You can also locate information concerning these adjustments in a technical service manual, or on the special tune-up decal in the engine compartment. You do not need to review any materials before beginning this objective.

After you have finished all the work activities for Performance Objective 28, your instructor will use a checklist like the one below to evaluate your work.

PERFORMANCE CHECKLIST—P.O. 28

The instructor will provide either a live vehicle or live engine. Adjust the carburetor idle mixture and idle speed. All of the performances below must be accomplished.

Student Performances

1. Hooks up tachometer to engine.
2. Adjusts idle speed screw to manufacturer's specifications.
3. Adjusts idle mixture screws to manufacturer's specifications.
4. Readjusts idle speed as necessary.
5. Removes tachometer.
6. Uses proper tools and equipment.
7. Follows all appropriate safety precautions.
8. Does performance in an acceptable amount of time.

Instructor Ratings

Acceptable	Not Acceptable	Omit
SAMPLE		

Tools and Equipment

For this objective, you will need to use the tools and equipment listed below. You will be given the procedures for using special tools and equipment as you work through the activities.

Basic Hand Tool Set

Special-Purpose Hand Tools

carburetor adjusting tool

Basic Equipment

fender covers
extension light
tachometer

Reading List

If you would like additional information as you work through this performance objective, use the references below.

General References

Crouse, *Automotive Mechanics,* pp. 195-96.
Crouse, *The Auto Book,* pp. 368-69.
Ellinger, *Automechanics,* pp. 142-43.
Stockel, *Auto Mechanics Fundamentals,* p. 133.
Stockel, *Auto Service and Repair,* pp. (20-16)-(20-17).
Toboldt and Johnson, *Automotive Encyclopedia,* p. 275.

Special-Purpose References

Ellinger, *Automotive Systems: Fuel, Lubrication, and Cooling,* pp. 73-78.
Crouse and Anglin, *Automotive Fuel, Lubricating, and Cooling Systems,* pp. 198-201.

Personal and Service Safety Practices

Safety When Working around an Operating Engine

- Avoid reaching into the engine without first looking, since your fingers can get caught in moving parts. Keep your hands away from the fan blades when you are adjusting the carburetor. If you get too close, injury can result.
- When adjusting the carburetor, be sure to place the extension light cord away from the engine fan.
- Always use fender covers when working under the hood. This keeps the fenders from getting scratched by tools, equipment, and belt buckles.

Safety in Work Clothing and Grooming

- Avoid wearing loose clothing or anything that can hang down and get caught in moving parts. Injury can result.

Loose clothing can also catch on engine parts and tear.

- Keep hair away from moving parts. If your hair is longer than conventional length, keep it under a hat.

CARBURETOR IDLE SPEED AND MIXTURE CONTROLS

Carburetor idle-speed systems supply gasoline to keep the engine operating when the throttle is closed. These systems are adjusted externally (outside) the carburetor. Two adjustment controls are adjusted: the engine idle speed and the idle fuel mixture. Both are extremely important because they affect engine idle operation, fuel economy, and exhaust emissions.

You can more easily locate idle speed and mixture controls if you know whether the carburetor you are working on has an idle speed solenoid.

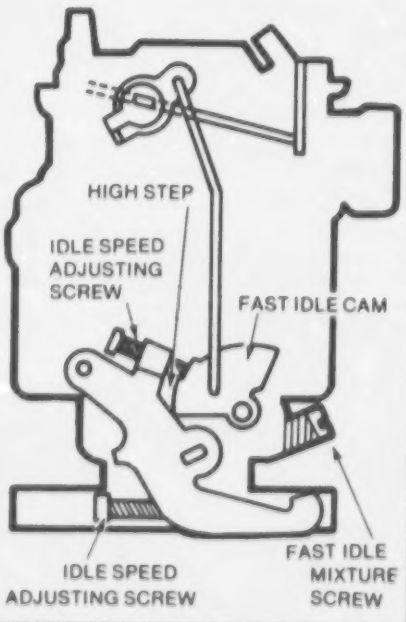
Carburetors without an Idle Speed Solenoid

Figure 28-1 shows a carburetor without an idle speed solenoid. Notice the position of the idle speed and idle mixture screws.

This type of carburetor has the following parts in the following locations:

- ***Idle speed screw***—located on the throttle linkage or sometimes on the throttle lever
- ***Idle mixture screws***—usually located at the base of the carburetor
- ***Fast idle speed adjusting screw*** (often mistaken for the idle speed screw)—located against the fast idle cam. You'll learn in another performance objective how to use the fast idle screw to service and adjust automatic chokes. DO NOT adjust this fast idle screw as you go through this performance objective.

Figure 28-1 Carburetor without an idle speed solenoid



Carburetors with an Idle Speed Solenoid

On carburetors with an idle speed solenoid, you'll find the idle speed screw and the idle mixture screw in the positions shown in Figure 28-2. The idle speed solenoid also has an adjusting screw and will need to be adjusted.

An idle speed solenoid is also called an ***anti-dieseling solenoid*** or an ***idle-stop solenoid*** because it prevents the engine from dieseling after the ignition key is turned off. The solenoid allows the throttle valve to close, keeping air-fuel mixtures from entering the intake manifold.

Figure 28-2 Carburetor with an idle speed solenoid

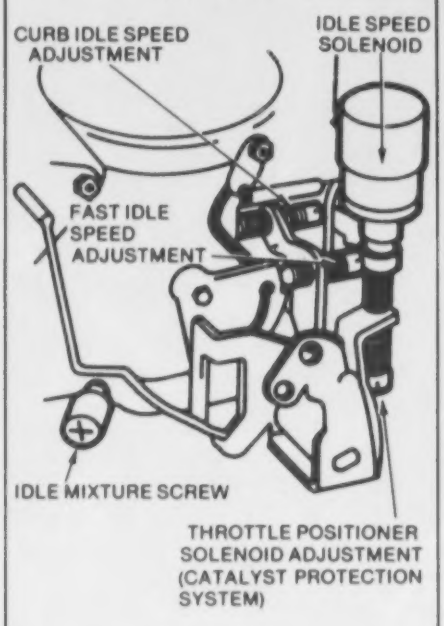
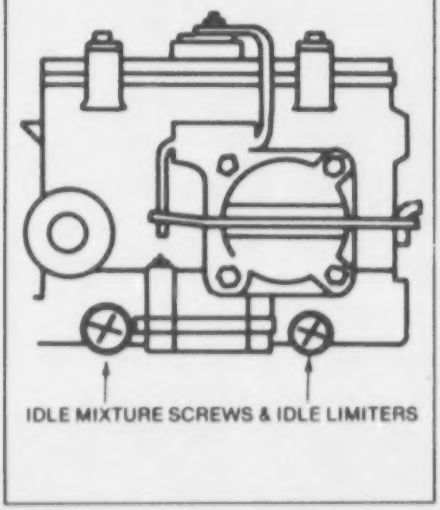

CURB IDLE SPEED ADJUSTMENT
IDLE SPEED SOLENOID
FAST IDLE SPEED ADJUSTMENT
IDLE MIXTURE SCREW
THROTTLE POSITIONER SOLENOID ADJUSTMENT (CATALYST PROTECTION SYSTEM)

Figure 28-4 Location of idle mixture screws



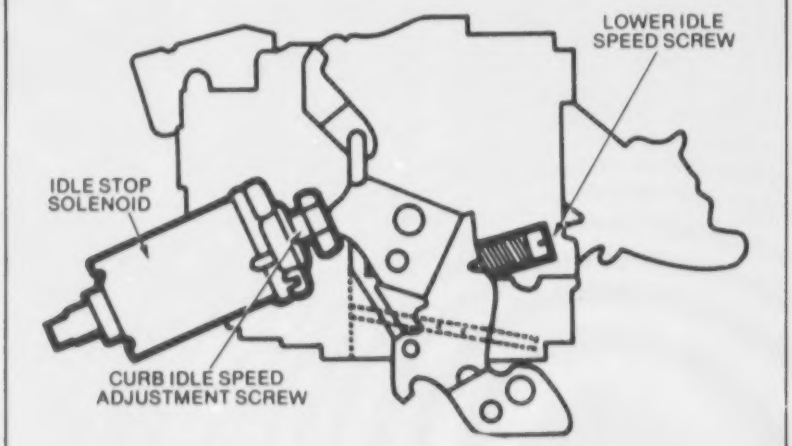
Idle speed solenoids, regardless of their location on the carburetor, have the plunger against the throttle linkage.

Always consult your technical service manual for specific instructions and specifications when adjusting idle speed, idle mixture, and idle speed solenoids.

CAUTION: NEVER adjust the plunger screw of a solenoid unless you're sure the solenoid is an idle speed solenoid. For example, some 1975 Chrysler carburetors look like they have idle speed solenoids, but they could be fast idle solenoids for air-conditioned vehicles.

There are two idle speed screws on some carburetors having an idle speed solenoid—one for curb idle and one for low idle, as shown in Figure 28-3. The ***curb idle speed screw*** is also called the ***plunger screw*** or the ***carburetor solenoid screw.***

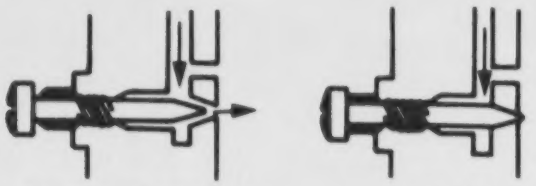
Figure 28-3 Carburetor with curb idle speed adjustment screw and lower idle speed screw



The lower idle speed screw is also called the ***carburetor idle cam screw*** or ***idle speed adjusting screw.*** Notice that these two idle speed screws are located on or at the throttle linkage. (***Low*** idle is the same as ***base*** idle. ***Curb*** idle is a ***higher*** RPM.)

The ***idle mixture screws,*** however, are located at the base of the carburetor, as shown in Figure 28-4. These screws are fine, tapered needles that are used to adjust the amount of fuel flow into the carburetor during engine idle. They should never be forced against their seats because it will form a groove in the needles' adjusting tapers and damage them (see Figure 28-5).

Figure 28-5 Correct and incorrect adjustments of the idle mixture screws



Idle limiters (also called ***idle mixture caps*** or ***idle mixture stop lugs)*** are installed over the mixture screws by the vehicle manufacturer (see Figure 28-6). The purpose of the idle limiters is to limit the adjustment of the mixture screw. That is, they keep you from turning the screw too far in one direction or the other, particularly away from enriching the mixture. (The tabs on the limiters will rest against a stop to prevent them from being turned further.)

There are two types of idle limiters—external and internal. They are shown in Figures 28-6 and 28-7.

Figure 28-6 External idle limiter

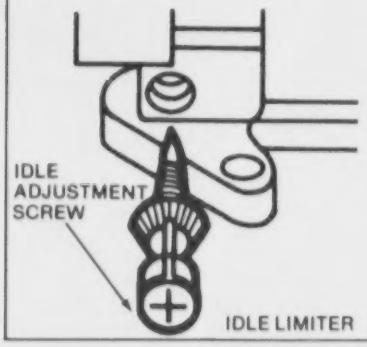
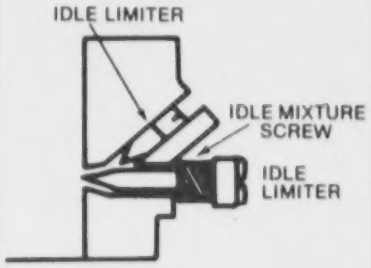


Figure 28-7 Internal idle limiter



It's necessary to adjust the idle mixture whether idle limiters are external or internal. But don't remove or damage the limiter cap. It's against the law to remove it in order to make the fuel mixture rich. (The limiter cap limits emission of hydrocarbons and carbon monoxide by keeping the fuel mixture within the specifications required by federal regulations.)

Hydrocarbons (HC) and Carbon Monoxide (CO)

Hydrocarbons (HC) and carbon monoxide (CO) are chemical compounds that pollute the air. They are found in the exhaust

emissions of burned fuel. If idle mixture is too rich, too much carbon monoxide and too many hydrocarbons are produced. If idle mixture is too lean, the engine won't run smoothly. Idle speed also affects idle mixture. So, you'll need to carefully adjust both idle speed and idle mixture to meet the emission control standards and to make the engine run smoothly.

UNDERSTANDING WRITTEN PROCEDURES

There are different procedures to follow for adjusting the idle mixture and idle speed on different vehicles. Not all procedures can be presented here, but some typical procedures will be presented and explained. Sometimes it's hard to understand the procedures listed in a technical service manual or on the decal in an engine compartment. You'll find these procedures easier to understand if you know that different words are used to mean the same thing. Here are some examples:

- ***Base idle*** is the same as ***low idle*** and ***slow idle.***
- ***Curb idle*** is the same as ***higher idle.***
- An ***idle speed solenoid*** is the same as an ***anti-dieseling solenoid*** and an ***idle-stop solenoid.***
- The ***solenoid plunger screw*** is the same as the ***carburetor solenoid screw.*** Sometimes, you'll need to ask your instructor to explain confusing information or words. Even the most experienced auto mechanic sometimes finds these procedures hard to understand.

FINDING INFORMATION ABOUT CARBURETOR ADJUSTMENTS

Technical Service Manual

The following are examples of instructions in the tune-up section of a technical service manual. These instructions include some of the basic steps for adjusting idle mixture and idle speed.

Example 1 **IDLE MIXTURE**

Make adjustment with engine at normal operating temperature, idle speed set, air cleaner installed, choke open, air conditioner off, fuel tank hose from vapor cannister disconnected and plugged. If necessary, check and correct timing. Connect tachometer and dwell-tachometer to vehicle and follow procedures below.

Example 2 **LEAN DROP (TACHOMETER) PROCEDURE**

Reconnect distributor vacuum hose. DO NOT remove limiter caps from mixture screws. Adjust idle to specified higher (curb) RPM. Turn mixture screws OUT equally until maximum RPM is reached. If necessary, readjust idle to specified

higher RPM. Turn mixture screws IN equally until specified lower RPM is reached.

Example 3

Engine Size and Type of Carburetor

Type of Transmission

Application	Higher (Curb) (RPM)	Lower (Base) (RPM)
262" 2-Bbl.		
Man.	900	800
Auto.	630	600
350" 2-Bbl.		
Man.	900	600
Auto.	650	600

Example 1 lists the same information as that listed on a decal in the engine compartment. Notice that Example 2 contains some steps that are different from those listed on the sample decal. (Figure 28-9 shows a sample decal.) Also notice in Example 2 that the steps are not listed one by one. Example 3 is different from Examples 1 and 2 since it lists RPM, engine size, type of carburetor, and type of transmission.

You may have noticed that RPM is described in different ways in the previous examples. Consider these three sentences, for example:

"Adjust idle to specified ***higher (curb) RPM.***"

"Turn mixture screws OUT equally until ***maximum*** RPM is reached."

"Turn mixture screws IN equally until specified ***lower*** RPM is reached."

Higher RPM is the same as curb idle. Example 3 specifies this higher (curb) RPM. ***Maximum RPM*** cannot be specified, except that it is the highest RPM that shows on the tachometer when you're adjusting the mixture screws. ***Lower (base) RPM,*** however, is specified. For example, 800 RPM is the lower (base) RPM for a 262-inch, 2-barrel carburetor on a vehicle with a manual transmission.

Carburetor Idle Speed Setting

Look at Figure 28-8. Notice that the first heading is ***HOT (SLOW) IDLE RPM. Hot*** idle is the same as ***base*** or ***low*** idle. Idle is "hot" since the engine must be at normal operating temperatures when you adjust the idle speed. The heading in Figure 28-8 also uses the word ***slow.*** Adjustment of the solenoid plunger screw is sometimes called ***solenoid slow idle adjustment*** instead of ***curb idle.***

In the same figure, RPM is shown under two headings: ***Solenoid Energized*** and ***Solenoid De-energized.*** One of the steps in adjusting the speed includes disconnecting the solenoid wire. The solenoid is ***de-energized*** when this wire is disconnected. The solenoid is ***energized*** when the wire is reconnected. This means that the specified energized

RPM of 800 and 650 is for idle speed with the solenoid wire connected. The specified de-energized RPM of 600 and 500 is for idle speed with the solenoid disconnected.

Figure 28-8 Sample directions for adjusting idle speed and idle mixture (for 1975 Oldsmobile with 6-cylinder engine)

HOT (SLOW) IDLE RPM

With engine at normal operating temperature, remove air cleaner. Disconnect air cleaner vacuum hose at intake manifold and plug fitting. Set parking brake and block drive wheels, open choke fully, air conditioning "OFF", vapor canister and EGR valve hoses disconnected and plugged at carburetor. Adjust timing to specifications, leaving vacuum hose to distributor connected. Adjust idle stop solenoid screw (energized) to specifications with automatic transmission in "D" or manual transmission in neutral. Then adjust carburetor idle screw to specifications (solenoid de-energized) with automatic transmission in "D" or manual transmission in neutral.

	Idle Speed (RPM)	
	Solenoid	Solenoid
Application	Energized	De-energized
Man. Trans.	800	600
Auto. Trans.	650	500

IDLE MIXTURE

Tachometer (Speed Drop) Procedure

With engine at normal operating temperature, disconnect vapor canister hose from air cleaner. Disconnect and plug distributor vacuum hose and EGR valve vacuum hose. Turn air conditioning off, leave air cleaner installed and place automatic transmission in "D". Set idle to specified "Solenoid Energized" RPM, then turn out (richen) mixture screws until maximum RPM is obtained. Reset idle speed (if required) using idle stop solenoid screw to 80 RPM above specified idle RPM. Turn in (lean) mixture screws until specified idle RPM is again obtained.

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One of the first steps in this example is to adjust the idle stop solenoid screw (energized) to specifications. The carburetor idle screw is then adjusted to specifications with the solenoid de-energized. In these procedures, the vacuum hose to the distributor is connected.

Carburetor idle mixture setting

One of the mixture adjustment steps includes turning the mixture screw IN until there's a certain RPM drop. This is called a lean drop (or speed drop) setting. The vacuum hose to the distributor is disconnected and plugged during the idle mixture speed drop procedure.

If the procedures refer you to some part of the vehicle that

you're not familiar with, such as the vapor canister and EGR valve hoses, find out where they're located. Look in the technical service manual or in other publications for a diagram of these parts. You can also ask your instructor to show them to you.

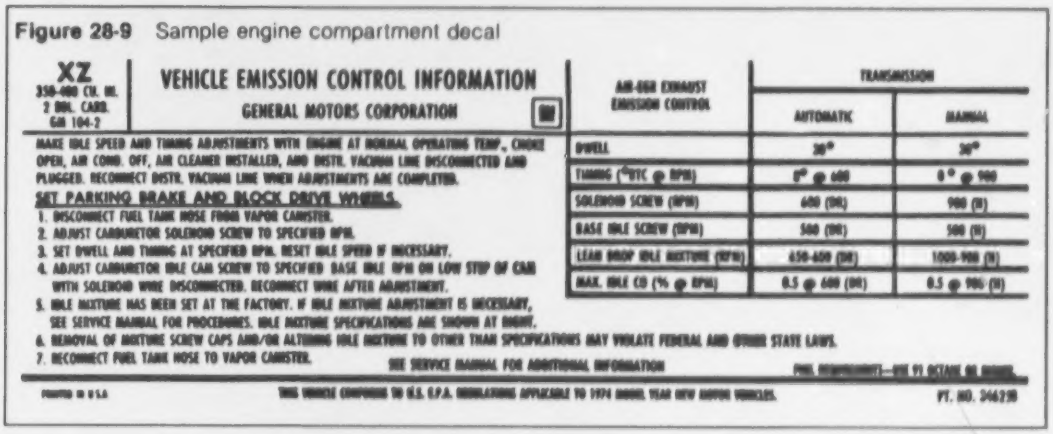
Take time to understand written procedures ***before*** you start adjusting idle speed and idle mixture. For example, be sure that you know when to connect and disconnect equipment and hoses. The procedures listed in a technical service manual or on a decal in the engine compartment often leave out such steps.

With practice, you'll be able to more quickly understand the procedures and set idle mixture and idle speed correctly for the particular vehicle you're working on.

Engine Compartment Decal

You can find some instructions on the decal in a vehicle's engine compartment. Figure 28-9 shows a typical decal.

Figure 28-9 Sample engine compartment decal


XZ
350-400 CU. IN.
2 BBL. CARB.
GM 104-2
VEHICLE EMISSION CONTROL INFORMATION
GENERAL MOTORS CORPORATION
AIR-GM EXHAUST EMISSION CONTROL
TRANSMISSION
AUTOMATIC
MANUAL
DWELL
TIMING
SOLENOID SCREW (RPM)
BASE IDLE SCREW (RPM)
LEAN DROP IDLE MIXTURE (RPM)
MAX. IDLE CO (% @ RPM)
MAKE IDLE SPEED AND TIMING ADJUSTMENTS WITH ENGINE AT NORMAL OPERATING TEMP., CHOKE OPEN, AIR COND. OFF, AIR CLEANER INSTALLED, AND DISTR. VACUUM LINE DISCONNECTED AND PLUGGED. RECONNECT DISTR. VACUUM LINE WHEN ADJUSTMENTS ARE COMPLETED.
SET PARKING BRAKE AND BLOCK DRIVE WHEELS.
1. DISCONNECT FUEL TANK HOSE FROM VAPOR CANISTER.
2. ADJUST CARBURETOR SOLENOID SCREW TO SPECIFIED RPM.
3. SET DWELL AND TIMING AT SPECIFIED RPM. RESET IDLE SPEED IF NECESSARY.
4. ADJUST CARBURETOR IDLE CAM SCREW TO SPECIFIED BASE IDLE RPM OR LOW STEP OF CAM WITH SOLENOID WIRE DISCONNECTED. RECONNECT WIRE AFTER ADJUSTMENT.
5. IDLE MIXTURE HAS BEEN SET AT THE FACTORY. IF IDLE MIXTURE ADJUSTMENT IS NECESSARY, SEE SERVICE MANUAL FOR PROCEDURES. IDLE MIXTURE SPECIFICATIONS ARE SHOWN AT RIGHT.
6. REMOVAL OF MIXTURE SCREW CAPS AND/OR ALTERING IDLE MIXTURE TO OTHER THAN SPECIFICATIONS MAY VIOLATE FEDERAL AND OTHER STATE LAWS.
7. RECONNECT FUEL TANK HOSE TO VAPOR CANISTER.
SEE SERVICE MANUAL FOR ADDITIONAL INFORMATION
PT. NO. 344218

Notice that the upper left corner of this figure specifies the engine size (350-400 cubic inches) and the type of carburetor (2-barrel).

The title tells you that this information is about vehicle emission control. Carburetor idle mixture adjustment must be done carefully so that emission control standards are met.

The information beneath the title lists the steps for preparing the vehicle for carburetor adjustment.

Look at the chart on the right side of the decal. There are two columns under ***Transmission***. If you're working on a vehicle with a manual transmission, you'll use the information in the ***Manual*** column. If you're working on a vehicle with an automatic transmission, you'll use the ***Automatic*** column. The first two items on the chart—dwell and timing—are not always part of idle speed and mixture adjustment. Notice also

that you may have set idle speed in Unit 3 as part of setting timing. But this performance objective is about setting different types of controls for idle speed and idle mixture as part of servicing the fuel system.

The chart also indicates that the vehicle must be in ***drive (DR)*** if it has an automatic transmission, and in ***neutral (N)*** if it has a manual transmission.

NOTE: Not all vehicles require idle adjustments with the automatic transmission in the ***drive*** position. Always check the vehicle manufacturer's directions.

CAUTION: Always set the parking brake and block the drive wheels before adjusting carburetor idle and mixture.

Turn to your Review Exercise Book and complete Exercise 15.

WORK ACTIVITIES

Do not begin any of these work activities until you have your instructor's approval. If you have any difficulty, review the pages listed next to each work activity. If you still have difficulty, ask your instructor for help.

1. In both a technical service manual and an engine compartment, find the instructions for adjusting idle speed and idle mixture. (pages 78-82) *Check your work with your instructor.*

2. Find a carburetor with an idle speed solenoid and another without an idle speed solenoid. Identify the idle speed screws, the idle mixture screws, and the idle limiters on each carburetor. (pages 75-78) NOTE: Use a technical service manual to help you identify these parts. *Check your work with your instructor.*

After you have finished these activities, go on to the next section.

ADJUSTING IDLE SPEED AND MIXTURE

Always follow the procedures recommended in the technical service manual or on the decal in the engine compartment for the vehicle you're working on. The procedures described below, however, may be used as a general guide.

CAUTION: Whenever you disconnect a hose, label it with masking tape. That way you'll be able to easily reconnect it to the right place.

Preparing for Adjusting Idle Speed and Mixture

STEP 1 Operate the engine until it warms up.

STEP 2 Be sure the air conditioner is off. The air conditioner

will decrease RPM. (In some cases the air conditioner needs to be on. Check the technical service manual or decal to find out which is correct.)

STEP 3 Be sure the vacuum hose from the carburetor to the distributor is connected to the distributor. (Sometimes the vacuum hose needs to be disconnected and plugged. Check the technical service manual or decal to find out which is correct.)

STEP 4 Be sure the choke valve is wide open. You'll want to remove the air cleaner to check it and then replace it.

STEP 5 If the air cleaner has a thermostatic valve, be sure the valve is open to outside air.

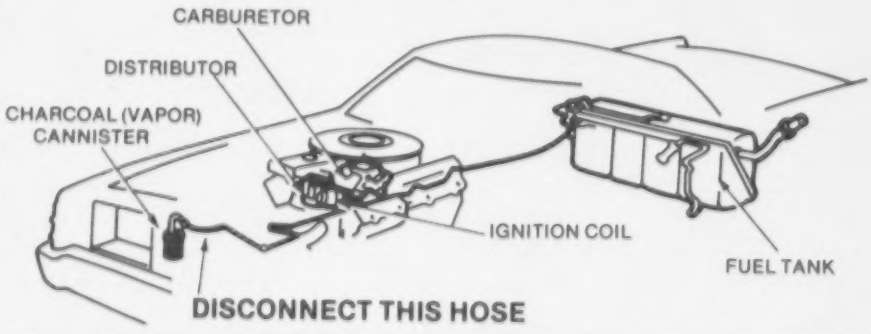
STEP 6 Be sure the air cleaner is on. (Reinstall the air cleaner if necessary.)

STEP 7 Place an automatic transmission in *Drive* if required. Place a manual transmission in *Neutral* if required.

STEP 8 Set the parking brake and block the drive wheels.

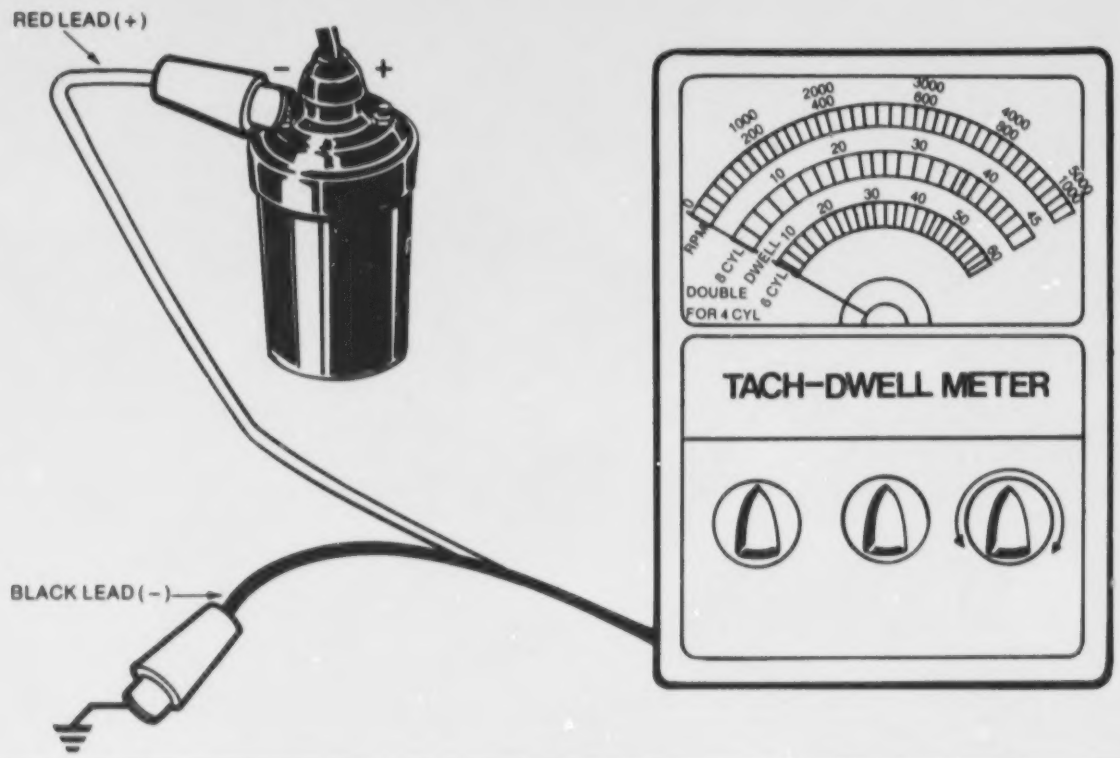
STEP 9 Disconnect the fuel tank hose from the vapor canister, as shown in Figure 28-10. (The vapor canister is the same as the charcoal or carbon canister.)

Figure 28-10 Disconnecting the fuel tank hose from the vapor canister



STEP 10 Connect the tachometer or dwell-tachometer (also called a tach-dwell meter). A dwell-tachometer is a combination of a dwell meter and tachometer. Follow the instructions that come with the meter. Usually, you'll connect the red (+) lead to the negative terminal on the ignition coil and the black (−) lead to the ground (see Figure 28-11).

Figure 28-11 Hookup for the tach-dwell meter



Adjusting Idle Speed and Mixture on a Carburetor without an Idle Speed Solenoid

After completing the preparation steps, follow these additional steps:

STEP 1 Turn the idle speed screw until the tachometer shows the specified RPM for low (base) idle.

Look at Figure 28-12. It shows the specifications for one make of vehicle. These specifications show that the specified idle is 900 RPM for a vehicle with a 350-cubic-inch engine that has a 4-barrel carburetor and a manual transmission. The specified idle is 700 RPM for the same type of vehicle with an automatic transmission. All other engine and carburetor applications for this type of vehicle have a specified idle speed of 800 RPM for a manual transmission and 600 RPM for an automatic transmission.

STEP 2 Turn one mixture screw IN (see Figure 28-13) until the tachometer shows a drop of 20 RPM (lean drop). (*IN* means *clockwise.* Turning the mixture screw IN makes the mixture more lean.)

Figure 28-12 Sample specifications for adjusting idle speed

Without Idle Speed Solenoid — If automatic transmission, place in "D". With engine running, turn idle speed screw to obtain specified RPM.

	Idle Speed (RPM)	
Application	Man. Trans.	Auto. Trans.
350" 4-Bbl. High Perf.	900	700
All Others	800	600

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Figure 28-13 Turning mixture screws in for leanness of mixture

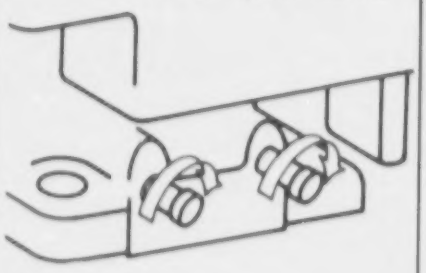
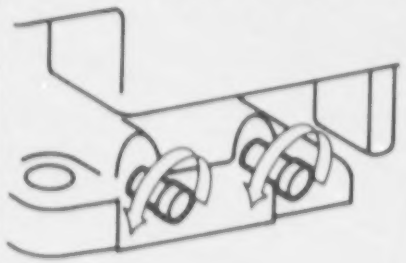


Figure 28-14 Turning mixture screws out for richness of mixture



STEP 3 Turn the mixture screw OUT 1/4 turn (see Figure 28-14). (*OUT* means ***counterclockwise.*** Turning the mixture screw OUT makes the mixture richer.)

STEP 4 Turn the other mixture screw IN until the tachometer shows a drop of 20 RPM.

STEP 5 Turn this same mixture screw OUT 1/4 turn.

STEP 6 Turn the idle speed screw again until the tachometer shows the specified RPM for low (base) idle.

Adjusting Idle Speed and Mixture on a Carburetor with an Idle Speed Solenoid

An idle speed solenoid is usually found on vehicles with a CCS (controlled combustion system). After completing the preparation steps, do the steps below.

STEP 1 The technical service manual or the decal in the engine compartment will tell you whether to disconnect the solenoid wire or to turn the air conditioner on.

STEP 2 Turn the low idle speed screw (carburetor idle speed screw) until the tachometer shows the specified RPM for low (base) idle.

Figure 28-15 shows specifications for a particular vehicle, indicating that the low idle speed is 500 RPM.

Figure 28-15 Sample specifications for adjusting idle speed on carburetor with idle speed solenoid

	Idle Speed (RPM)	
Application	Low Idle	Curb Idle
454"	500	600

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After you turn the low idle speed screw, check a technical service manual or the decal in the engine compartment to find out whether to reconnect the solenoid wire or to turn the air conditioner off.

STEP 3 Turn the curb idle speed screw (carburetor solenoid screw or solenoid plunger screw) IN or OUT until the tachometer shows the specified RPM for curb (higher) idle.

STEP 4 Do Steps 3, 4, 5, 6, and 7 under ***adjusting idle mixture on carburetors without an idle speed solenoid.***

STEP 5 Readjust low and curb idle speeds as necessary to meet specified RPM.

Other Procedures for Adjusting Idle Speed and Mixture

The lean-drop procedure may vary, depending on the particular vehicle you're working on. For example, the set of instructions in Figure 28-16 require idle speed setting on "solenoid energized" RPM.

Figure 28-16 Sample specifications for idle speed setting on solenoid energized RPM

	Idle Speed (RPM)	
Application	Solenoid Energized	Solenoid De-energized
Man. Trans.	800	600
Auto. Trans.	650	500

IDLE MIXTURE

TACHOMETER (SPEED DROP) PROCEDURE

With engine at normal operating temperature, disconnect vapor canister hose from air cleaner. Disconnect and plug distributor vacuum hose and EGR valve vacuum hose. Turn air conditioning off, leave air cleaner installed and place automatic transmission in "D". Set idle to specified "Solenoid Energized" RPM, then turn out (richen) mixture screws until maximum RPM is obtained. Reset idle speed (if required) using idle stop solenoid screw to 80 RPM above specified idle RPM. Turn in (lean) mixture screws until specified idle RPM is again obtained.

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Lean drop for manual transmission (see Figure 28-16)

Turn the mixture screw OUT (rich) until the maximum RPM is reached. Then turn the idle stop solenoid screw until the tachometer shows 80 RPM more than the specified idle RPM.

The tachometer should now show 880 RPM.

Turn the mixture screws IN (lean) until the tachometer shows 800 RPM again.

Lean drop for automatic transmission (see Figure 28-16)

Turn the mixture screws OUT (rich) until the maximum RPM is reached. Then turn the idle stop solenoid screw until the tachometer shows 80 RPM more than the specified idle RPM. The tachometer should now show 730 RPM.

Turn the mixture screws IN until the tachometer shows 650 RPM again.

After adjusting idle mixture and idle speed, you may need to check the HC and CO levels with an ***exhaust emission analyzer.***

You'll learn how to use the exhaust emission tester and adjust the carburetor to obtain the proper HC-CO levels in Performance Objective 39.

Turn to your Review Exercise Book and complete Exercise 16.

WORK ACTIVITIES

Do not begin any of these work activities until you have your instructor's approval. If you have any difficulty, review the pages listed next to each work activity. If you still have difficulty, ask your instructor for help.

3. **Adjust the idle mixture and idle speed on a carburetor without an idle speed solenoid. (pages 84-85)** *Check your work with your instructor.*

4. **Adjust idle mixture and idle speed on a carburetor with an idle speed solenoid. (pages 85-86)** *Check your work with your instructor.*

After you have finished these activities, ask your instructor to return your pretest on Performance Objective 28. Complete the questions that you missed or were unable to answer the first time you took the pretest. Check your answers with your instructor when you finish. Your instructor will then tell you if you are ready to be checked off on the performance checklist or if you need to correct some of your answers first.

If you are told by your instructor that you are ready for the performance checklist, carefully tear the checklist out of your Review Exercise Book and give it to your instructor.

PERFORMANCE OBJECTIVE 29
CLEAN AND ADJUST THE AUTOMATIC CHOKE UNIT

INTRODUCTION TO P.O. 29

As part of a tune-up service, you'll need to inspect, clean, and adjust the automatic choke unit. The carburetion section of a technical service manual contains diagrams and instructions for adjusting automatic choke units.

The automatic choke helps to meter fuel and air according to the engine compartment temperature. When the engine is cold and is first cranked, it needs a richer fuel in order to start and to keep running. The choke closes off some of the air so that the air-fuel mixture will be richer. As the engine warms up, the choke opens automatically to gradually increase the amount of air in the air-fuel mixture so that the mixture will be leaner. The automatic choke must be in working order so that the mixture can go from rich to lean at the right times.

In this objective, you'll learn what parts make up an automatic choke unit and how to inspect, disassemble, clean, and adjust an automatic choke unit. You'll learn how to perform these steps for two types of automatic choke units. One type has a ***choke piston*** to help move the parts in the automatic choke. The other type has a ***vacuum break*** to help move the parts. Both the choke piston and vacuum break are operated by a vacuum created by the operation of the engine.

After you have finished all the work activities for Performance Objective 29, your instructor will use a checklist like the one on the following page to evaluate your work.

PERFORMANCE CHECKLIST—P.O. 29

The instructor will provide either a live vehicle or live engine. Clean and adjust an automatic choke. All the performances below must be accomplished.

Student Performances	Instructor Ratings		
	Acceptable	Not Acceptable	Omit
1. Removes carburetor air cleaner assembly.			
2. Inspects and cleans choke unit parts as necessary.			
3. Adjusts intermediate choke rod (or adjusts choke piston position).			
4. Adjusts thermostatic choke coil (or adjusts automatic choke setting).			
*5. Adjusts choke coil rod.			
*6. Adjusts fast idle cam.			
*7. Adjusts vacuum break and auxiliary break (if so equipped).			
8. Adjusts the unloader.			
9. Makes operational check of all adjustments and installs air cleaner assembly.			
10. Uses proper tools and equipment.			
11. Follows all appropriate safety precautions.			
12. Does performance in an acceptable amount of time.			

SAMPLE

*These steps should be omitted if the choke is piston-operated.

Tools and Equipment

For this objective, you will need to use the tools and equipment listed below. You will be given the procedures for using special tools and equipment as you work through the activities.

Basic Hand Tool Set

Basic Equipment

fender covers
extension light
compressed air hose
compressed air blowgun

Safety Equipment

eye protection

Reading List

If you would like additional information as you work through this performance objective, use the references below.

General References

Crouse, *Automotive Mechanics*, pp. 177-81, 346.
Crouse, *The Auto Book*, pp. 205-07.
Ellinger, *Automechanics*, pp. 25-26, 138.
Stockel, *Auto Mechanics Fundamentals*, pp. 130, 138-41.
Stockel, *Auto Service and Repair*, pp. (20-21)-(20-24).
Toboldt and Johnson, *Automotive Encyclopedia*, pp. 259-64.

Special-Purpose References

Ellinger, *Automotive Systems: Fuel, Lubrication, and Cooling*, pp. 48-50, 81-85.

Crouse and Anglin, *Automotive Fuel, Lubricating, and Cooling Systems*, pp. 87-93.

Personal and Service Safety Practices

Safety in Work Clothing and Grooming

- Keep hair away from moving parts. If hair is longer than conventional length (over shirt collar), wear a hair net or keep it under a hat.
- Avoid wearing loose clothing or anything that can hang down and get caught in moving parts. Injury can result. Loose clothing can also catch on engine parts and tear.
- Avoid wearing any metal (rings, buckles, wristwatch bands, necklaces, etc.). If metal comes in contact with an electrical part, you can be severely burned.

Safety When Working around an Operating Engine

- Always use fender covers when working under the hood. Fender covers will keep fenders from getting scratched by tools, equipment, and belt buckles.
- Avoid reaching into the engine without first looking, since your fingers can get caught in moving parts.

BASIC COMPONENTS AND OPERATION OF AN AUTOMATIC CHOKE

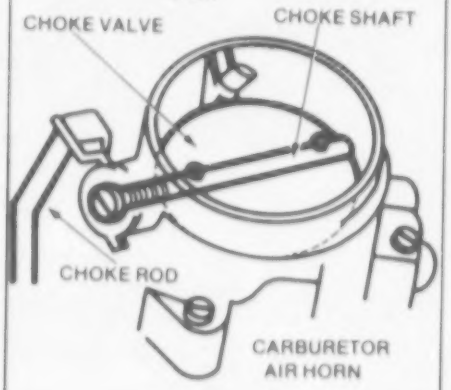
Most automatic choke units have a choke valve, choke shaft, choke piston or vacuum break, thermostatic coil, filter screen, and choke levers and linkages. Choke units also have choke/throttle linkages, a fast idle cam, and an unloader.

Each of these parts is described in this section.

Choke Valve and Choke Shaft

This is the part of the choke unit that opens and closes. It sits in the top part of the carburetor air horn, as shown in Figure 29-1. The ***choke shaft*** is the part that turns to open and close the ***choke valve***. This valve is also called a butterfly valve. As the choke valve opens, it lets in more air. As it closes, it chokes off air.

Figure 29-1 Carburetor showing the choke valve and choke shaft



Choke Piston

The choke piston is connected to the choke lever. When the engine is started, the engine vacuum pulls the piston. Tension on the thermostatic coil holds the choke valve closed (see Figure 29-2) when the engine is cold. When the engine starts, the intake manifold vacuum pulls the piston and lever, thus partially opening the choke valve while the engine is warming up. As the engine warms up, the thermostatic coil relaxes its tension. This allows the choke valve to open.

Figure 29-2 Choke mechanism on a carburetor

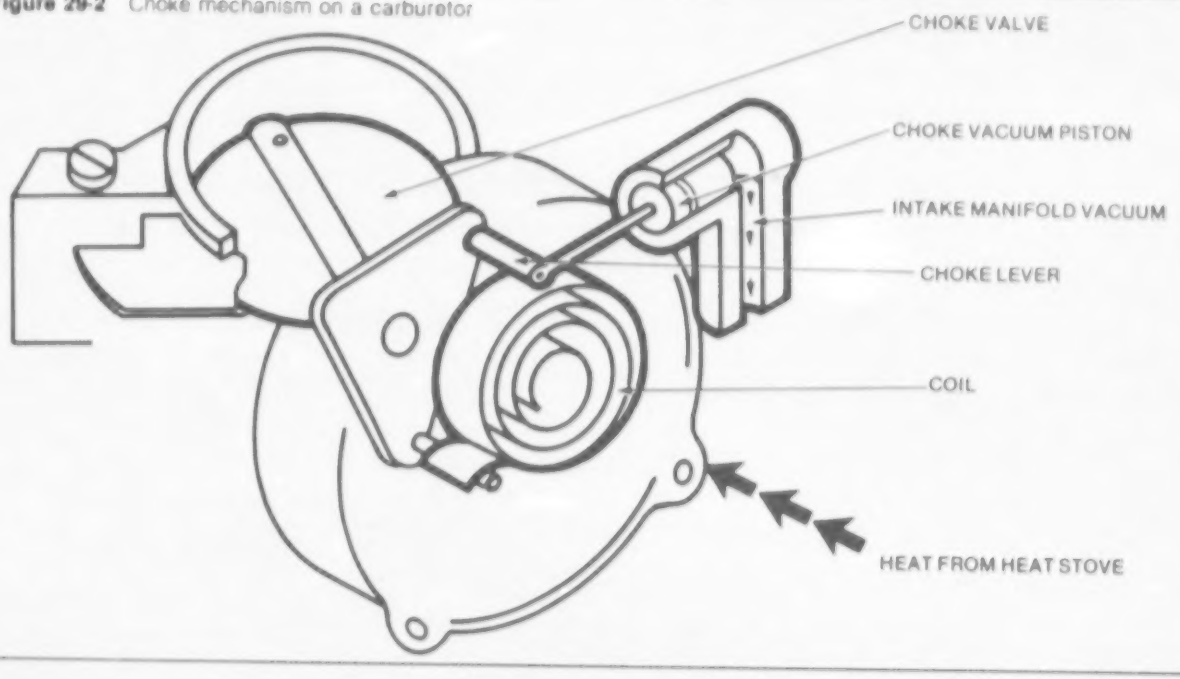


Figure 29-3 Location of the vacuum break on the choke unit

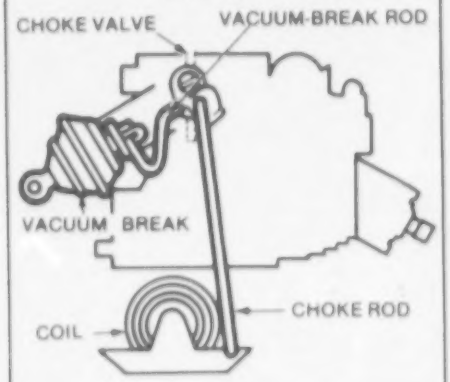
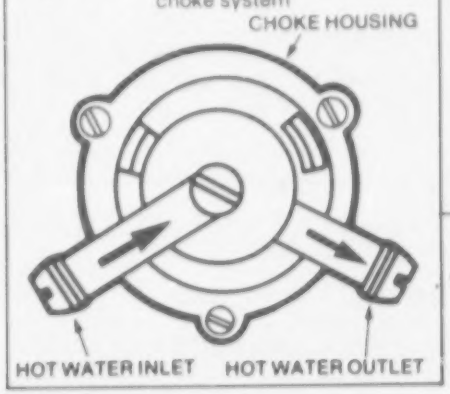


Figure 29-4 Thermostatic coil

Figure 29-6 Choke housing for hot water choke system



Vacuum Break

The vacuum break is a vacuum control unit mounted outside the carburetor, as shown in Figure 29-3. It operates by engine vacuum in the same way as the choke piston. A diaphragm inside the vacuum break moves the choke linkage or choke valve.

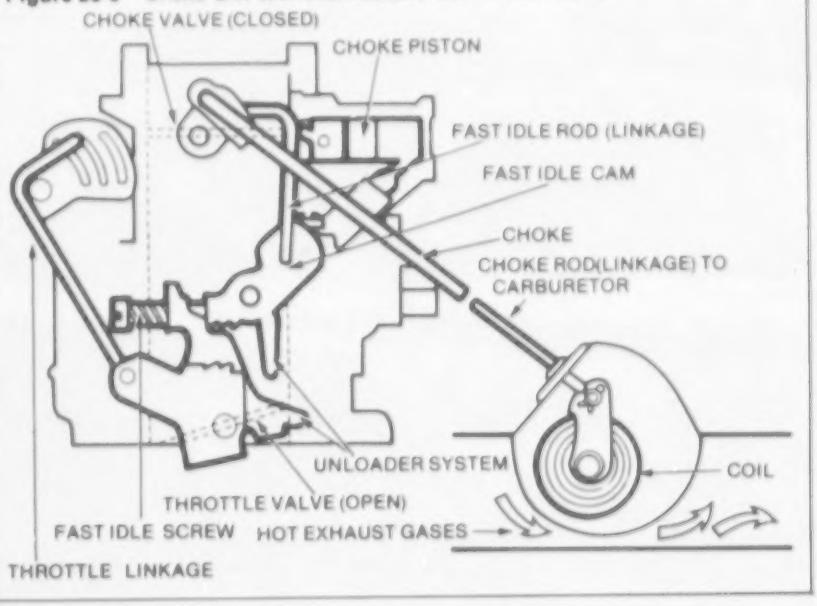
Thermostatic Coil

A thermostatic coil is a spring that responds to changes in temperature (see Figure 25-4). When the engine is cold, the coil is wound tightly. As the engine temperature rises, the coil unwinds slowly and relaxes its tension. The coil is usually connected to the choke valve by a lever or linkage.

There are several ways in which the coil may be heated.

- One way is to enclose the coil in a cap and then pipe warm air to it from the exhaust manifold by way of a heat stove (see Figure 29-2).
- Another thermostatic coil arrangement is one in which the coil is placed directly in a recess in the intake manifold. A long choke rod connects the coil link to the choke valve link (see Figure 29-5).

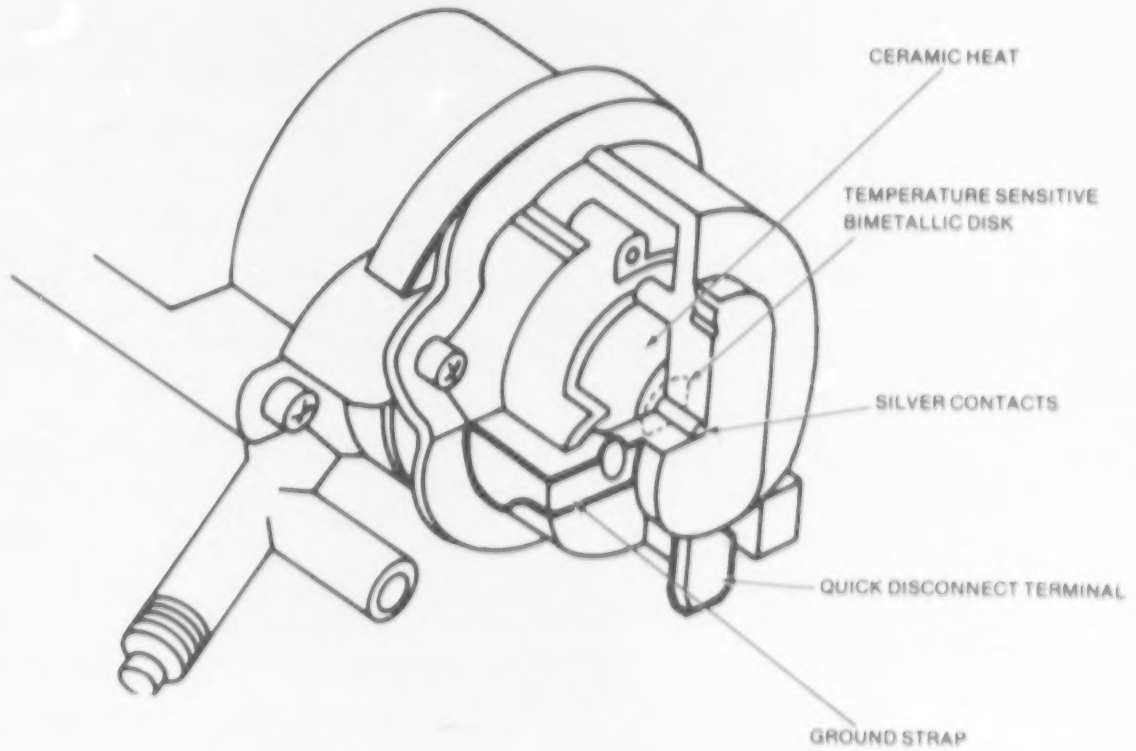
Figure 29-5 Choke unit with thermostatic coil in heat stove



- Some thermostatic coils are heated by water. The hot water comes from the engine cooling system. It enters at the hot water inlet and leaves through the hot water outlet (see Figure 29-6).

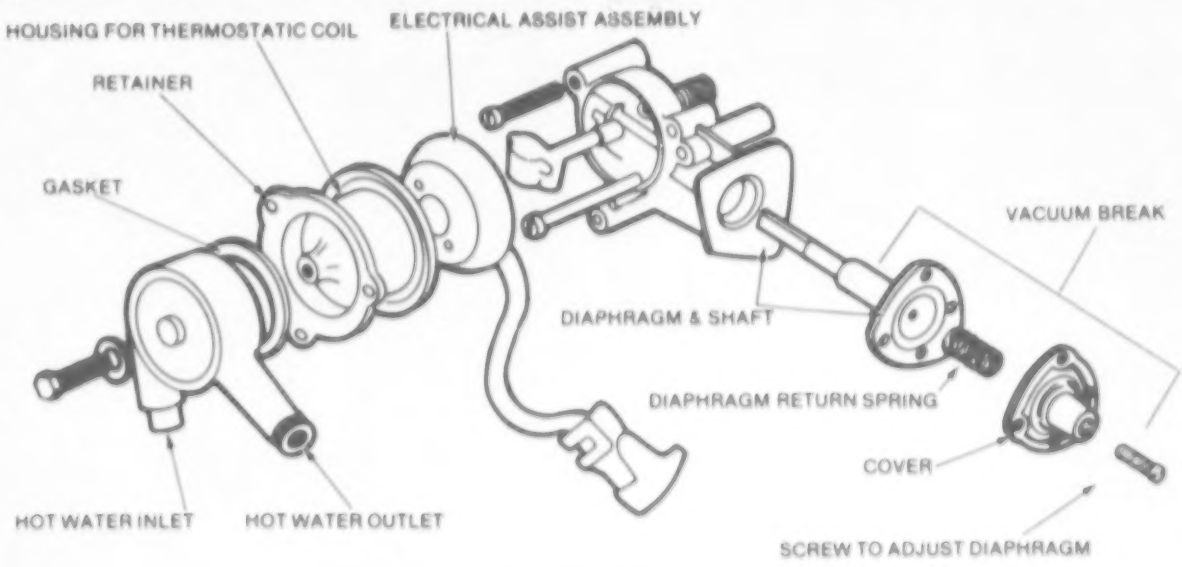
- Another type of coil assembly has an electric heating element inside the automatic choke housing. The heat from these electrical parts helps to open the choke valve faster (see Figure 29-7).

Figure 29-7 Choke unit with an electrical heating element



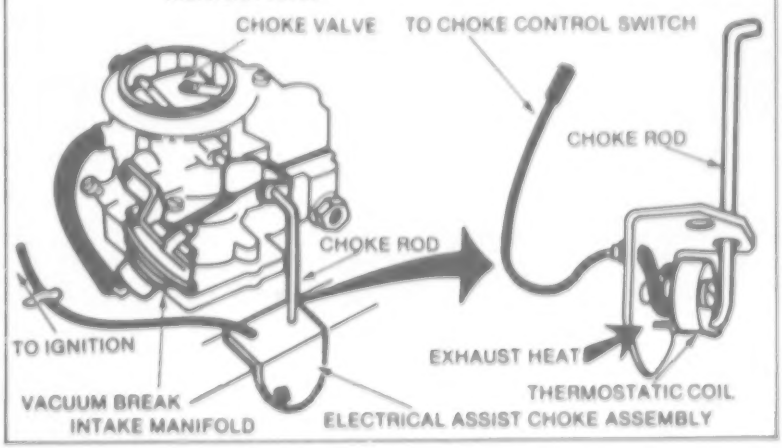
- A more complex thermostatic coil unit has more than one heat source. The one shown in Figure 29-8 shows the hot water and electrical assist parts. These combine to heat up the thermostatic coil faster. Figure 29-8 also shows you the interior of a vacuum break unit.

Figure 29-8 Choke unit with hot water and electrical assist parts



- The last automatic choke arrangement has the thermostatic coil with an electrical assist mounted in the heat stove (see Figure 29-9). You'll again notice the use of the vacuum break unit.

Figure 29-9 Choke unit with thermostatic coil electrically assisted in intake manifold recess



Choke Filter Screen

Some automatic choke units also have a *screen* that filters the air as it comes from the heat stove into the choke housing (see Figure 29-10). The choke filter screen prevents dirt and other particles from getting inside the choke housing and clogging the moving parts. If the screen gets too dirty, it will block off the flow of heated air. This will keep the automatic choke unit from opening at the proper time.

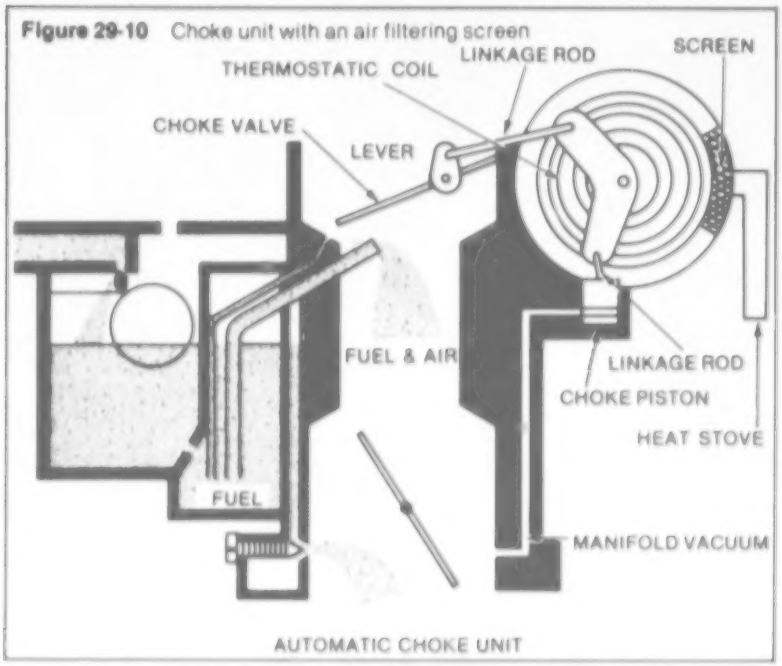


Figure 29-10 Choke unit with an air filtering screen

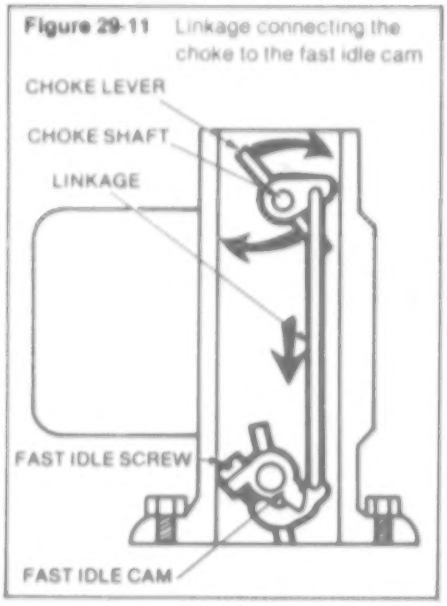


Figure 29-11 Linkage connecting the choke to the fast idle cam

Choke/Throttle Linkage

In addition to the choke levers and linkages connecting the thermostatic coil and vacuum break units to the choke valve, there is also direct linkage between the throttle valve and the choke valve.

Fast Idle Cam and Linkage

In Figure 29-11, the linkage connects the choke to a fast idle cam located on the throttle shaft. The purpose of the fast idle cam is to allow the engine to operate at fast idle when the engine is cold and the choke valve is partially open.

The fast idle screw located on the throttle linkage rests against the fast idle cam. It controls idle RPM when the engine is cold. When the choke opens, the fast idle cam moves away from the fast idle screw. Engine idle is then controlled by the idle speed screw on the throttle linkage.

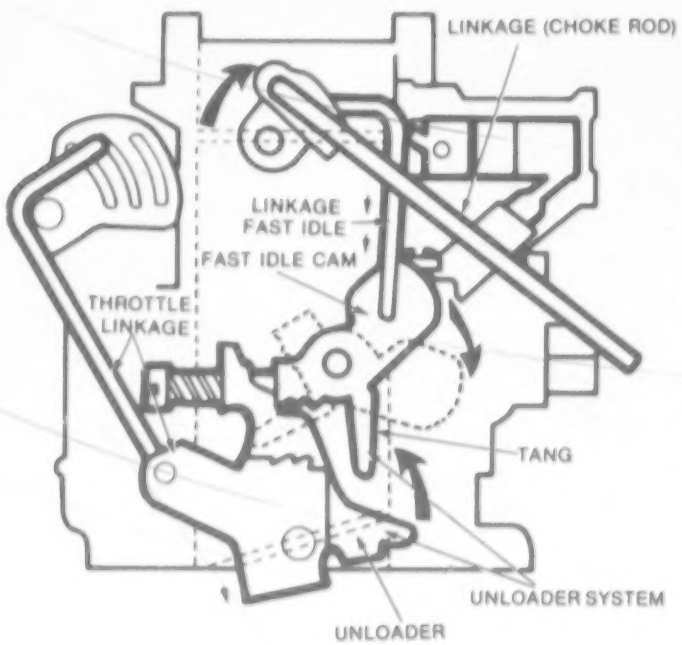
On some carburetors, there may be only one idle speed screw. On these carburetor models, the idle speed screw also rests against the cam. To adjust low idle, the screw is set on a low step of the cam. To adjust fast idle, the screw is set on a high step of the cam. These differences are usually apparent in the procedures listed in a technical service manual.

Since fast idle is adjusted differently on different types of carburetors, it would be helpful to check the technical service manual carefully for the type of carburetor you'll be working on. (Adjustment procedures are described in a later part of the Student Guide for this performance objective.)

Unloader

The unloader system allows the choke valve to open mechanically when the throttle valve is moved to a wide-open position, as shown in Figure 29-12.

Figure 29-12 Choke unit showing how the unloader works



The heavy black arrow in this figure shows the way the bottom of the unloader moves up to hit the tang. When this happens, the fast idle cam pulls down on the fast idle rod to open the choke valve. This allows more air to move in through the top of the carburetor.

If the engine doesn't start right away and the choke valve is closed, too much fuel may cause the engine to flood. The unloader works to counter the effects of flooding by opening the choke valve. This allows more air to enter the intake manifold.

Turn to your Review Exercise Book and complete Exercise 17.

WORK ACTIVITY

Do not begin the work activity until you have your instructor's approval. If you have any difficulty, review the pages listed next to each work activity. If you still have difficulty, ask your instructor for help.

1. Look at several vehicle automatic choke units and identify the parts and linkages that make up each system. (pages 95-101) *Check your work with your instructor.*

After you have finished this activity, go on to the next section.

CLEANING AND ADJUSTING AUTOMATIC CHOKE UNITS

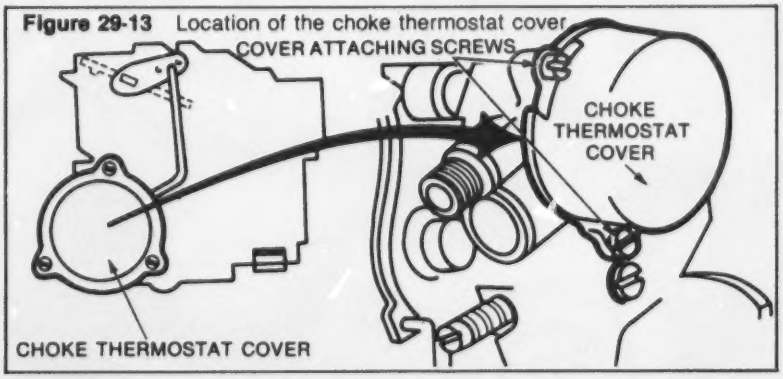
In this section, you'll learn how to clean and adjust two types of automatic choke units: ***piston-operated*** and ***vacuum-break-operated.***

Before you begin cleaning and adjusting an automatic choke unit, look in the carburetion section of a technical service manual for the correct procedures and specifications.

Cleaning and Adjusting Piston-Operated Automatic Choke Units

Piston-operated choke units are usually found on vehicles manufactured before 1970. If you look at the outside of the unit, you can easily identify the ***choke thermostat cover,*** shown in Figure 29-13. The choke thermostat cover is also called a choke or thermostat housing.

Figure 29-13 Location of the choke thermostat cover.



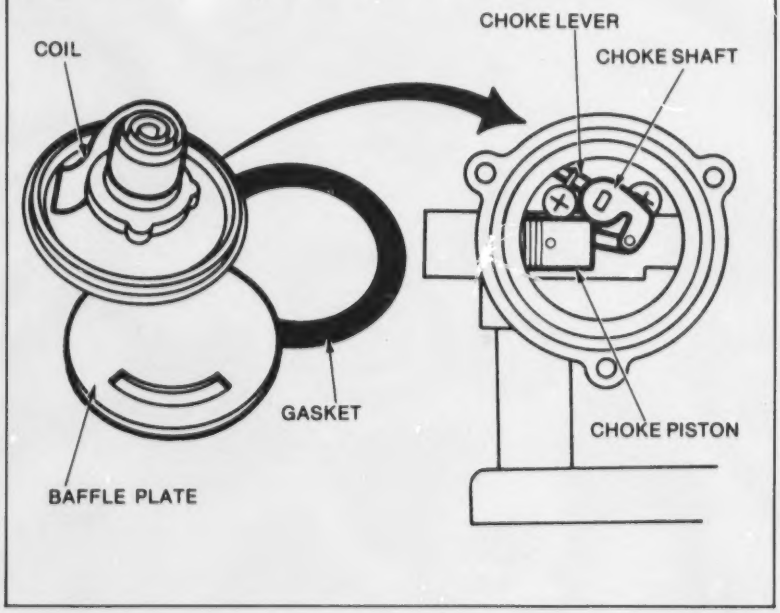
Inspecting and cleaning the piston-operated choke unit

STEP 1 Remove the air cleaner.

STEP 2 Loosen the screws and remove the cover carefully, noting the position of the thermostatic coil. The coil must be put back in exactly the same way.

STEP 3 Put the gaskets and the baffle plate in a safe place. The arrows in Figure 29-14 show you where the end of the spring fits onto the choke lever.

Figure 29-14 Choke unit in disassembly process



STEP 4 Check the linkage and piston to be sure they're moving freely.

STEP 5 Check the choke butterfly valve and shaft for free and smooth movement.

STEP 6 Check the unloader linkage for free movement.

STEP 7 Remove and check the filter screen (if there is one) to see whether it's dirty.

STEP 8 If any of these parts require cleaning, spray them with a choke cleaning solvent.

STEP 9 After cleaning the parts with solvent, dry them with compressed air.

NOTE: If the filter screen cannot be cleaned with the solvent and compressed air, simply replace it with a new screen.

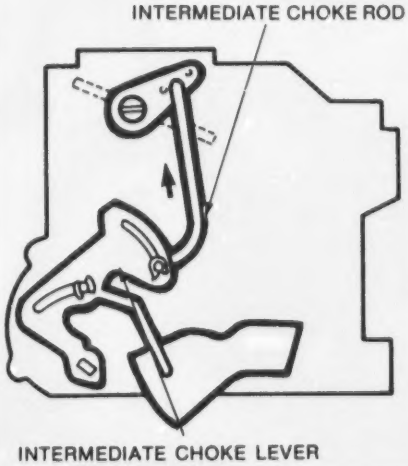
There are at least three adjustments to make on piston-type automatic chokes. They are:

- intermediate choke rod adjustment (piston position)
- automatic choke setting (thermostat cover)
- unloader adjustment

Technical service manuals contain some adjusting procedures. Look for headings like these:

- Intermediate Choke Rod (Choke Piston)
- Choke Piston Settings
- Automatic Choke (2GC Carbs.)
- Hot Water Choke Coil
- Choke Rod (2GC & 2GV Carbs.)
  —Carburetors with Single Connector Rod
  —Carburetors with Split Choke
- Unloader

Figure 29-15 Pushing up on choke lever to close choke valve



Adjusting the intermediate choke rod (piston)

After you have set aside the gaskets, plate, cover, and coil, you can adjust the choke rod.

STEP 1 Open the throttle valve (see Figure 29-12). Push down on the throttle linkage until the throttle valve is completely open.

STEP 2 Push up on the intermediate choke lever to close the choke valve (see Figure 29-15).

Look at the position of the choke piston in Figure 29-16. Notice that the end of the piston is flush (even) with the top end of the cylinder.

STEP 3 Find the choke piston position for the vehicle you're working on. Look at Figure 29-17.

Figure 29-16 Choke piston is flush with top end of cylinder

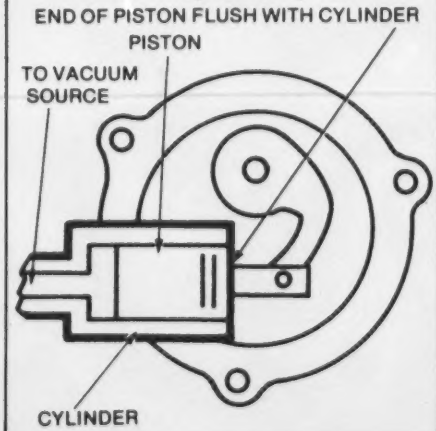


Figure 29-17 Specifications for choke piston position

CAR MODEL	CHOKE PISTON POSITION
1962	Flush
1965	.030" Out
1962-1964	1st "V" Groove Flush

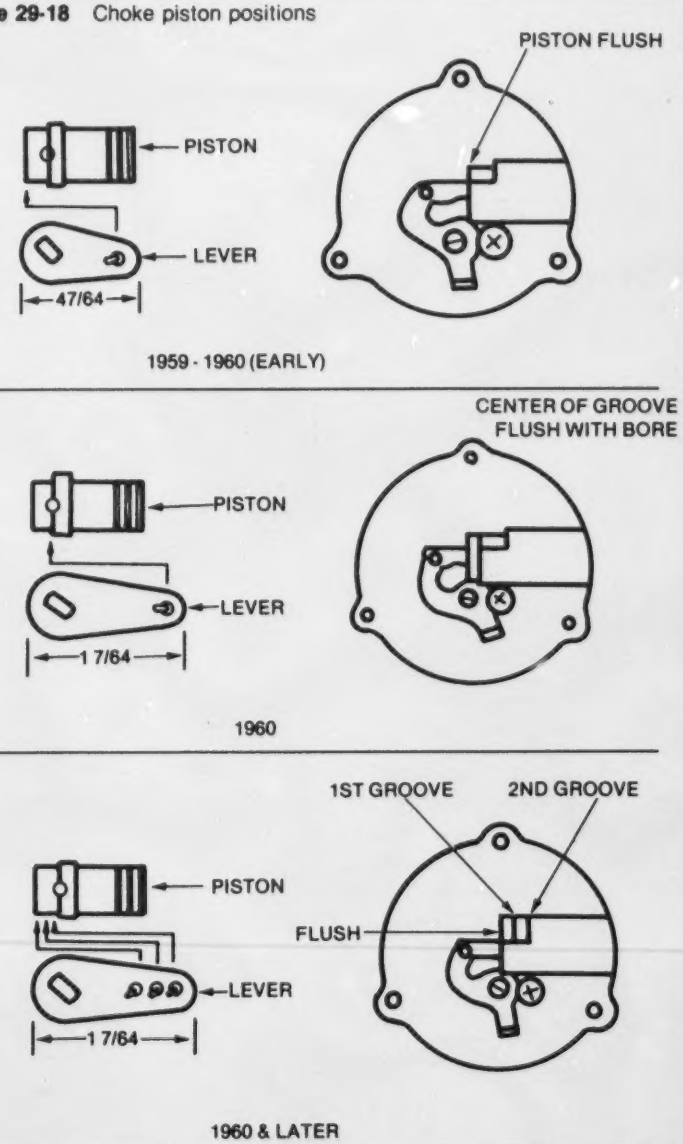
- *Flush* means that the end of the piston should be even with the top end of the cylinder.
- *.030" Out* means that the end of the piston should be .030 inches beyond the end of the cylinder.

NOTE: You may need to use a wire gauge to determine how far the end of the piston is from the end of the cylinder.

- *1st "V" Groove Flush* means that the first groove around the piston should be flush with the end of the cylinder.

In Figure 29-18, notice the differences in the piston flush, the center of groove flush with cylinder bore, and the first groove flush.

Figure 29-18 Choke piston positions



Adapted from *Delco Carburetor Parts Service Manual. Carburetor Models 2G, 2GC, 2GV Service Manual 9D-3A.* ©1975 General Motors Corporation. Used with permission of Delco-Remy Division, General Motors Corporation.

STEP 4 If the piston isn't in the position specified in the technical service manual, adjust the intermediate choke rod. Use a carburetor linkage bending tool to bend the curved part of the intermediate choke rod until the piston is in the correct position (see Figure 29-19).

Figure 29-19 Steps for adjusting the choke piston

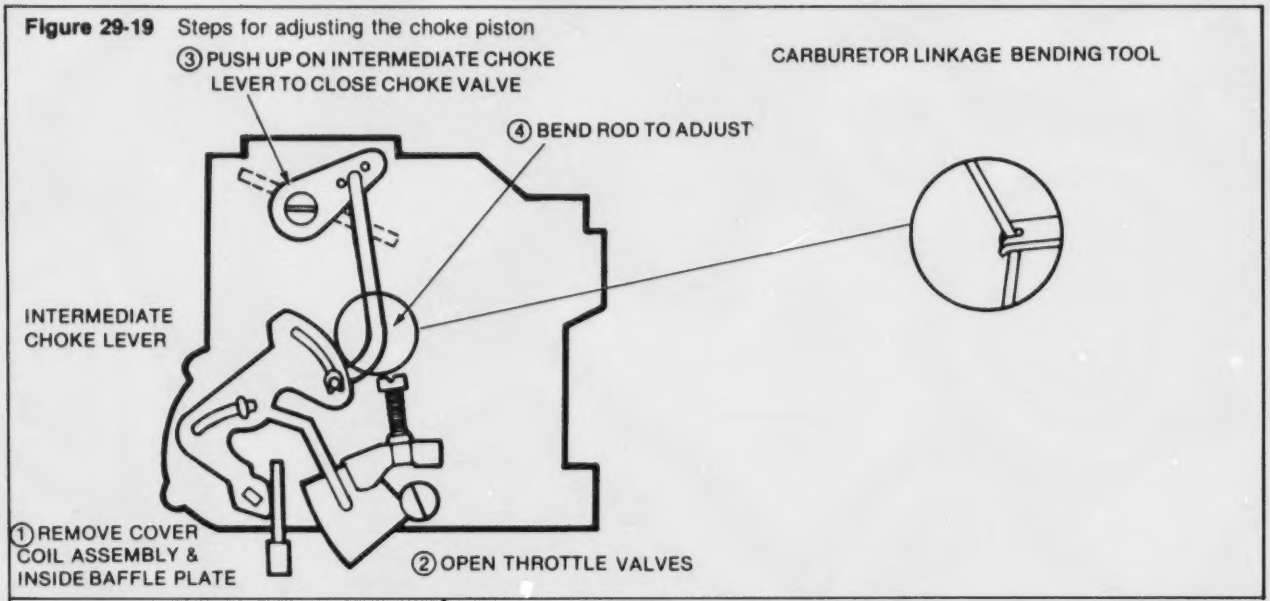
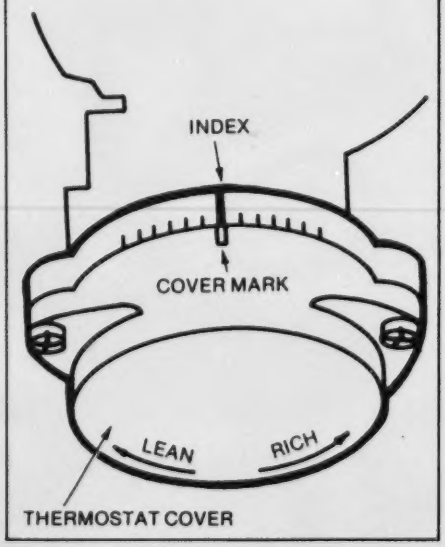

③ PUSH UP ON INTERMEDIATE CHOKE LEVER TO CLOSE CHOKE VALVE
CARBURETOR LINKAGE BENDING TOOL
④ BEND ROD TO ADJUST
INTERMEDIATE CHOKE LEVER
① REMOVE COVER COIL ASSEMBLY & INSIDE BAFFLE PLATE
② OPEN THROTTLE VALVES

Figure 29-20 Aligning index markings



Adapted from *Delco Carburetor Parts Service Manual. Carburetor Models 2G, 2GC, 2GV Service Manual 9D-3A.* © *1975 General Motors Corporation. Used with permission of Delco-Remy Division, General Motors Corporation.*

Setting the automatic choke (thermostat cover)

STEP 1 Be sure the choke screen is installed in the housing of the choke.

STEP 2 Install the plate and the thermostat cover gasket.

STEP 3 Install the thermostat cover and coil assembly. Be sure the thermostatic coil spring fits onto the choke lever properly.

STEP 4 Rotate the cover assembly until the marking on the cover is aligned with the index marking on the carburetor (see Figure 29-20).

STEP 5 Install and tighten the cover attaching screws.

Look in the technical service manual under ***carburetor adjustment specifications*** and follow the choke setting specifications. The manual will list the specifications by the carburetor identification number or name. Index, 1NR, and 1L are some examples of recommended settings.

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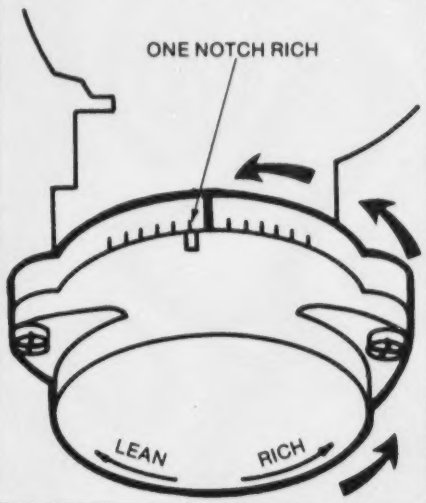
Figure 29-21 Setting the thermostat cover one notch rich



Index means to set the thermostat cover on the index line. It's like a "zero" reference line. The large mark on the cover should match up with the index mark (see Figure 29-20). On each side of the index there are a number of raised markings on the carburetor body. These markings are called ***notches.***

1NR means to set the thermostat cover at one notch rich. Turn the cover of the thermostat in the "rich" direction marked on the cover (see Figure 29-21).

1L means to set the thermostat cover one notch lean. Turn the cover of the thermostat in the "lean" direction marked on the cover (see Figure 29-22).

Adjusting the unloader

Figure 29-23 shows the steps for the unloader adjustment. Be sure to check the technical service manual for the correct wire gauge size to use in Step 2. When completing Step 3, bend the tang only until the correctly sized gauge moves in and out of place with just a little friction on each side.

Figure 29-22 Setting the thermostat cover one notch lean

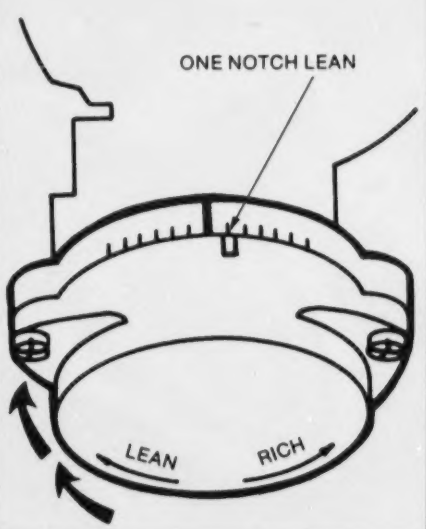
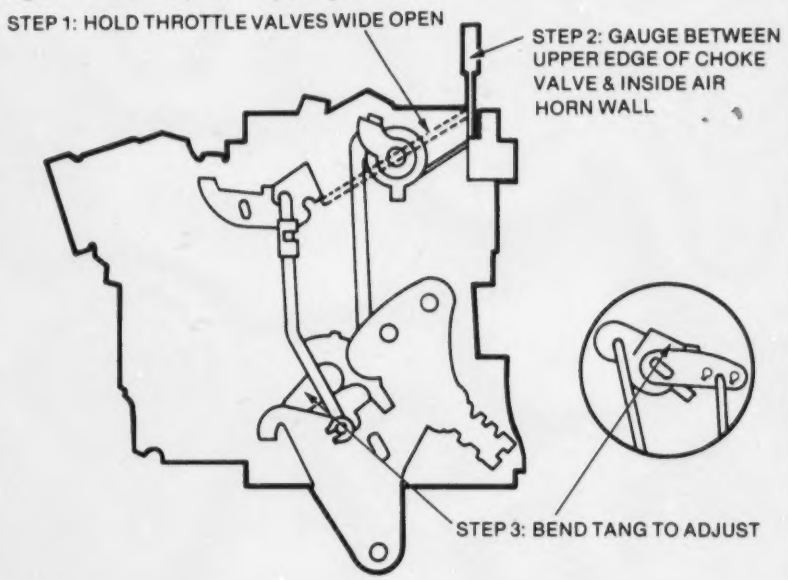


Figure 29-23 Steps for adjusting the unloader


STEP 1: HOLD THROTTLE VALVES WIDE OPEN
STEP 2: GAUGE BETWEEN UPPER EDGE OF CHOKE VALVE & INSIDE AIR HORN WALL
STEP 3: BEND TANG TO ADJUST

Adapted from ***Delco Carburetor Parts Service Manual. Carburetor Models 2G, 2GC, 2GV Service Manual 9D-3A.*** ©1975 General Motors Corporation. Used with permission of Delco-Remy Division, General Motors Corporation.

NOTE: The choke valve will change position as you bend the tang. When doing these procedures, hold the throttle valves wide open by holding the throttle linkage in the wide-open position.

After you have made all the necessary adjustments, check to be sure all the components are reassembled.

STEP 1 With the engine cold, partially open the carburetor throttle. The choke should be closed.

STEP 2 Open the throttle all the way. The choke unloader should partially open the choke valve.

STEP 3 Start the engine. The choke should open during the warm-up period.

REMEMBER: The choke closes when the engine is cold, and opens automatically as the engine warms up.

Turn to your Review Exercise Book and complete Exercise 18.

WORK ACTIVITIES

Do not begin any of these work activities until you have your instructor's approval. If you have any difficulty, review the pages listed next to each work activity. If you still have difficulty, ask your instructor for help.

2. Inspect and clean the parts of a choke piston. (pages 102-103) *Check your work with your instructor.*

3. Adjust the choke piston to the vehicle manufacturer's specifications. (page 103) *Check your work with your instructor.*

4. Adjust the automatic choke thermostatic coil to the vehicle manufacturer's specifications. (pages 103-105) *Check your work with your instructor.*

5. Adjust the choke unloader to the vehicle manufacturer's specifications. (pages 106-107) *Check your work with your instructor.*

6. Make an operational check of your work. (page 107) *Check your work with your instructor.*

After you have finished these activities, go on to the next section.

Cleaning and Adjusting Vacuum-Break-Operated Automatic Choke Units

Vacuum-break automatic chokes are usually found on vehicles manufactured after 1970.

Clean and adjust all parts as necessary, being sure to follow the same steps as those for inspecting and cleaning a piston-type choke unit.

To adjust this type of unit, you'll need to find the appropriate section in a technical service manual. You should look for headings like these:

- Vacuum Break (2GV Carbs.)
- Vacuum Break Setting

Delco's service manual for the model "G" two-barrel Rochester carburetors describe some typical procedures for adjusting an automatic choke unit with vacuum break. A copy of some of these procedures is included in the following pages.

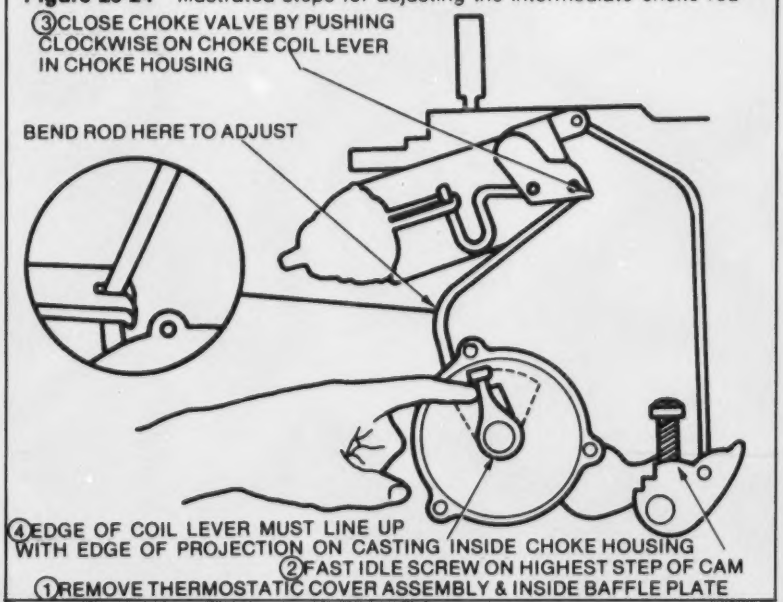
There are six basic adjustments to make on a vacuum-break automatic choke, depending upon the make and model of the carburetor. The parts that must be adjusted are:

- the intermediate choke rod
- the automatic choke setting (thermostat cover)
- the choke coil rod
- the fast idle cam
- the vacuum break
- the unloader

Adjusting the intermediate choke rod

Figure 29-24 shows a sample of the instructions you'll find in a technical service manual for adjusting the intermediate choke rod on an automatic choke with vacuum break.

Figure 29-24 Illustrated steps for adjusting the intermediate choke rod


③CLOSE CHOKE VALVE BY PUSHING CLOCKWISE ON CHOKE COIL LEVER IN CHOKE HOUSING
BEND ROD HERE TO ADJUST
④EDGE OF COIL LEVER MUST LINE UP WITH EDGE OF PROJECTION ON CASTING INSIDE CHOKE HOUSING
②FAST IDLE SCREW ON HIGHEST STEP OF CAM
①REMOVE THERMOSTATIC COVER ASSEMBLY & INSIDE BAFFLE PLATE

Adapted from *Delco Carburetor Parts Service Manual. Carburetor Models 2G, 2GC, 2GV Service Manual 9D-3A.* ©1975 General Motors Corporation. Used with permission of Delco-Remy Division, General Motors Corporation.

Figure 29-25 Fast idle screw on highest step of cam

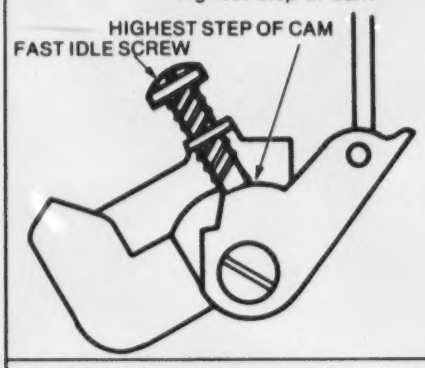


Figure 29-26 Closing the choke valve

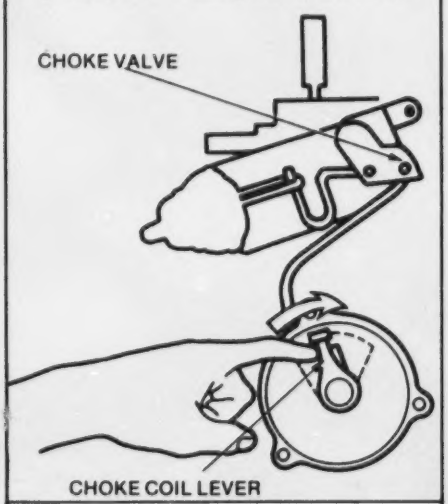
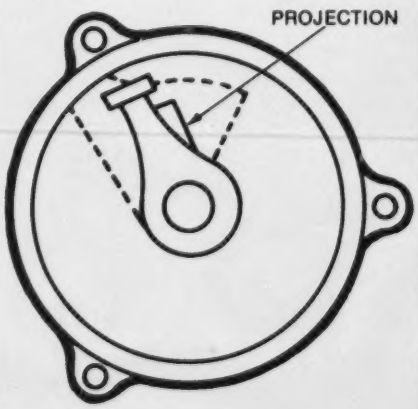


Figure 29-27 Lining up coil lever



Each of these steps is explained below.

STEP 1 ***Remove thermostatic cover, coil assembly, and inside baffle plate.*** Follow the same procedure as the one used for the choke piston unit.

STEP 2 ***Fast idle screw on highest step of cam.*** This means you'll need to remove the choke rod and the fast idle linkage so that the fast idle screw rests on the highest step of the cam, as shown in Figure 29-25.

STEP 3 ***Close the choke valve by pushing clockwise on choke coil lever in choke housing.*** This means you'll need to push clockwise against the choke coil lever until the choke valve is closed (see Figure 29-26).

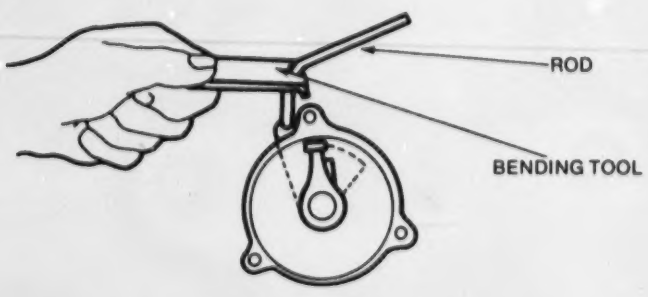
NOTE: On other carburetors, you may need to push on a different part of the linkage or in a different direction to close the choke valve. The technical service manual usually shows which part to push and in what direction the part should be pushed.

STEP 4 ***Edge of coil lever must line up with edge of projection on casting inside choke housing.*** This means that the edge of the coil lever should line up with an outline or ridge marker on the inside of the choke housing (see Figure 29-27). If it doesn't line up with this projection, you'll need to adjust it according to Step 5.

NOTE: Step 4 may be stated differently for other types of carburetors.

STEP 5 ***Bend rod here to adjust coil lever.*** This means you'll need to use a carburetor linkage bending tool to bend the rod until the coil lever is in the correct position (Step 4). Always make your bend at the curved part of the rod (see Figure 29-28).

Figure 29-28 Bending coil rod to adjust coil lever



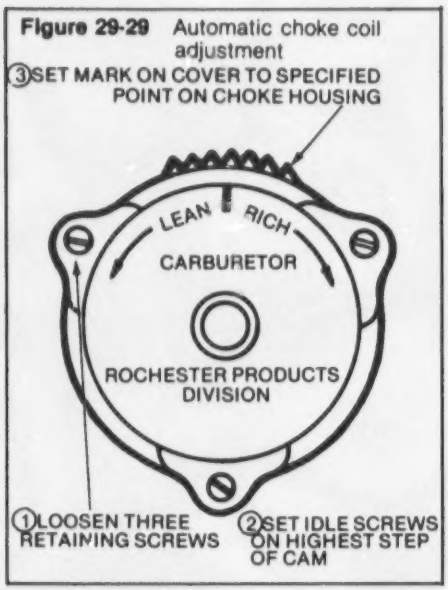

③SET MARK ON COVER TO SPECIFIED POINT ON CHOKE HOUSING
LEAN
RICH
CARBURETOR
ROCHESTER PRODUCTS DIVISION
①LOOSEN THREE RETAINING SCREWS
②SET IDLE SCREWS ON HIGHEST STEP OF CAM

Figure 29-29 Automatic choke coil adjustment

Adapted from *Delco Carburetor Parts Service Manual. Carburetor Models 2G, 2GC, 2GV Service Manual 9D-3A.* ©1975 General Motors Corporation. Used with permission of Delco-Remy Division, General Motors Corporation.

These five steps complete the intermediate choke rod adjustment for one type of automatic choke unit. If you can understand these steps, you should be able to follow most other steps listed in a technical service manual for this adjustment.

Setting the automatic choke (thermostat cover)

Figure 29-29 shows the basic procedure for adjusting an automatic choke coil.

Adjusting the choke coil rod

Figure 29-30 shows the basic procedure for adjusting the choke coil rod on a typical automatic choke.

Adjusting the choke rod fast idle cam

On most vacuum-break automatic choke units, you'll be able to make a fast idle adjustment with the carburetor on the engine. Sometimes, however, you won't be able to make this adjustment until the carburetor is removed from the engine. Check the technical service manual to see whether the type of carburetor you're working on can be left on the engine while you make the fast idle adjustment. Before adjusting the choke rod, follow the procedures for positioning the slow and fast idle screws. (Refer to the written procedures in Figure 29-31 to adjust the choke rod and the low idle speed screw.)

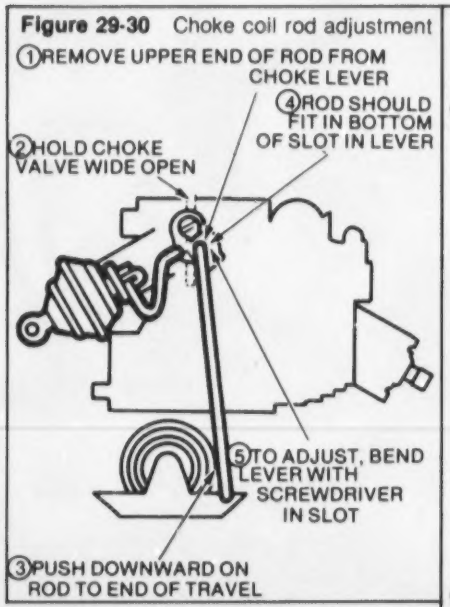

①REMOVE UPPER END OF ROD FROM CHOKE LEVER
④ROD SHOULD FIT IN BOTTOM OF SLOT IN LEVER
②HOLD CHOKE VALVE WIDE OPEN
⑤TO ADJUST, BEND LEVER WITH SCREWDRIVER IN SLOT
③PUSH DOWNWARD ON ROD TO END OF TRAVEL

Figure 29-30 Choke coil rod adjustment

Adapted from *Delco Carburetor Parts Service Manual. Carburetor Models 2G, 2GC, 2GV Service Manual 9D-3A.* ©1975 General Motors Corporation. Used with permission of Delco-Remy Division, General Motors Corporation.

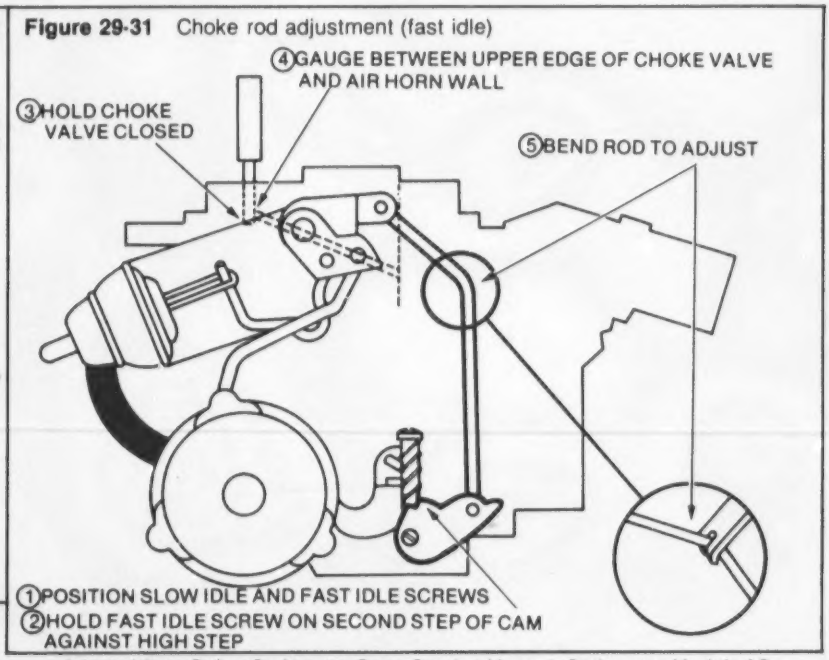

④GAUGE BETWEEN UPPER EDGE OF CHOKE VALVE AND AIR HORN WALL
③HOLD CHOKE VALVE CLOSED
⑤BEND ROD TO ADJUST
①POSITION SLOW IDLE AND FAST IDLE SCREWS
②HOLD FAST IDLE SCREW ON SECOND STEP OF CAM AGAINST HIGH STEP

Figure 29-31 Choke rod adjustment (fast idle)

Adapted from *Delco Carburetor Parts Service Manual. Carburetor Models 2G, 2GC, 2GV Service Manual 9D-3A.* ©1975 General Motors Corporation. Used with permission of Delco-Remy Division, General Motors Corporation.

Adjusting the vacuum break

Figure 29-32 is a sample of instructions in a technical service manual on how to adjust a vacuum break.

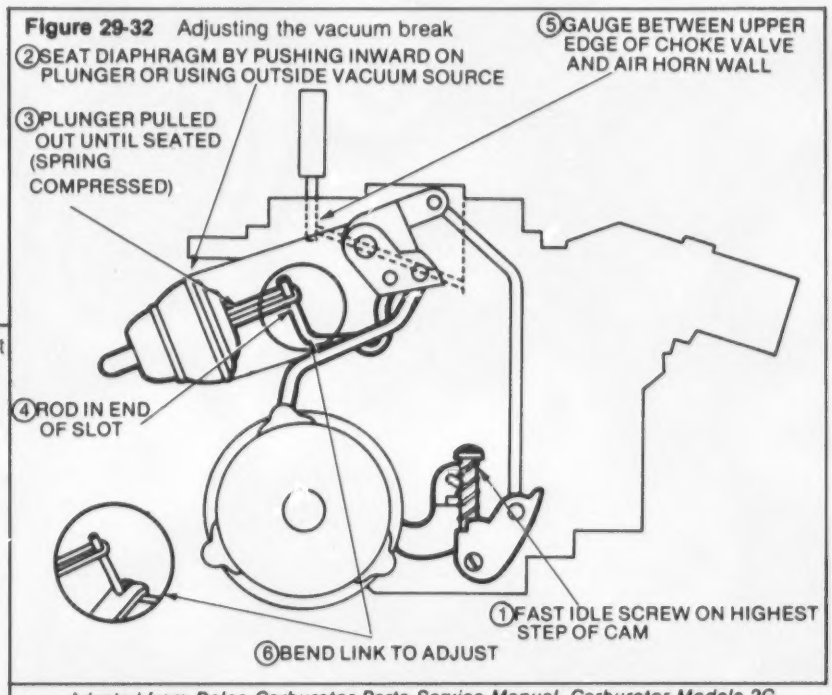

⑤GAUGE BETWEEN UPPER EDGE OF CHOKE VALVE AND AIR HORN WALL
②SEAT DIAPHRAGM BY PUSHING INWARD ON PLUNGER OR USING OUTSIDE VACUUM SOURCE
③PLUNGER PULLED OUT UNTIL SEATED (SPRING COMPRESSED)
④ROD IN END OF SLOT
①FAST IDLE SCREW ON HIGHEST STEP OF CAM
⑥BEND LINK TO ADJUST

Figure 29-32 Adjusting the vacuum break

Adapted from *Delco Carburetor Parts Service Manual. Carburetor Models 2G, 2GC, 2GV Service Manual 9D-3A.* ©1975 General Motors Corporation. Used with permission of Delco-Remy Division, General Motors Corporation.

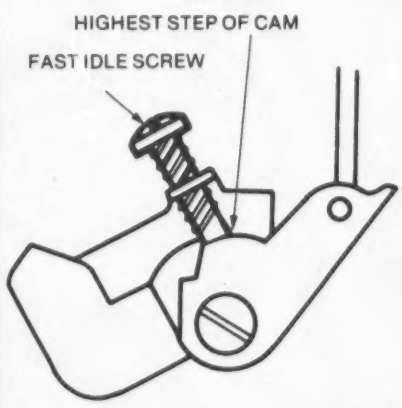


Figure 29-33 Fast idle screw on highest step of cam

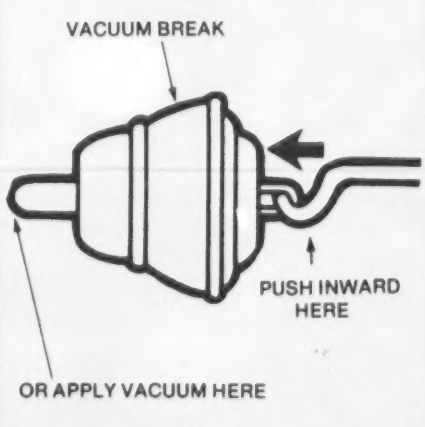


Figure 29-34 Push inward on plunger to seat diaphragm

Each of these steps is explained below.

STEP 1 ***Fast idle screw on highest step of cam.*** This means you'll need to set the fast idle screw on the highest step of the cam.

NOTE: This step isn't needed for some types of carburetors. You also may find for some types of carburetors that the position of the fast idle screw should be on a different part of the cam. So be sure to follow the directions you find in the technical service manual.

STEP 2 ***Seat diaphragm by pushing inward on plunger or using outside vacuum source.*** Figure 29-34 shows where to push inward on the plunger. It also shows where to attach a hand vacuum pump to apply a vacuum. The diaphragm plunger is seated when the plunger that is connected to the diaphragm stops moving.

Figure 29-35 Plunger pulled out until seated

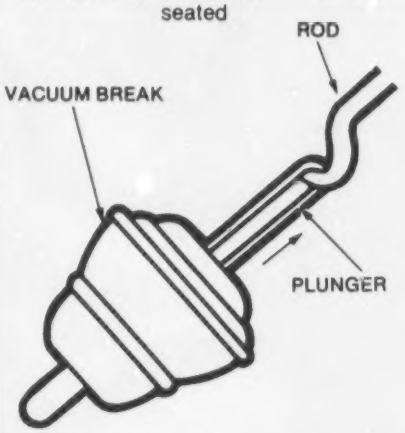


Figure 29-36 Gauging the choke valve

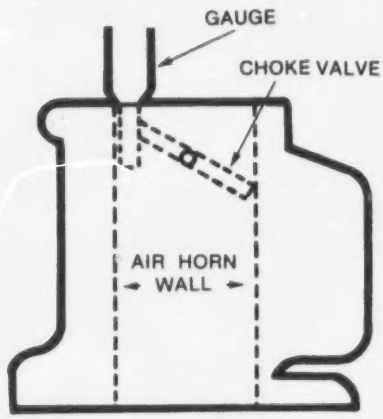
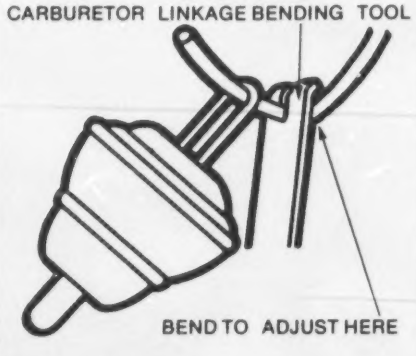


Figure 29-38 Bend rod to adjust vacuum break



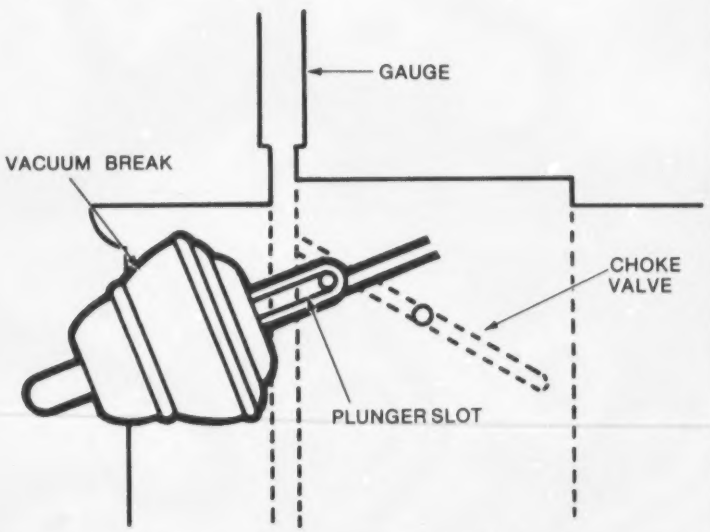
STEP 3 ***Plunger pulled out until seated (spring compressed).*** This means you'll need to pull out the plunger, as shown in Figure 29-35. The diaphragm is seated when the plunger can't be moved any further away from the diaphragm.

STEP 4 ***Rod in end of slot.*** This means that the correct position for the rod is at the end of the plunger slot, as shown in Figure 29-35. This is where the rod should be when the proper wire gauge is used, as described in Step 5.

STEP 5 ***Gauge between upper edge of choke valve and air horn wall.*** To do this step, you'll need to find the carburetor adjustment specifications in a technical service manual.

- Use the model number for the carburetor you're working on to find the gauge size for adjusting the vacuum-break choke rod.
- Place the gauge between the upper edge of the choke valve and the air horn wall (see Figure 29-36).
- Check the position of the choke rod. It should be in the position specified in the technical service manual. For example, Step 4 stated the rod should be at the end of the slot, as shown in Figure 29-37.

Figure 29-37 Rod is at end of slot

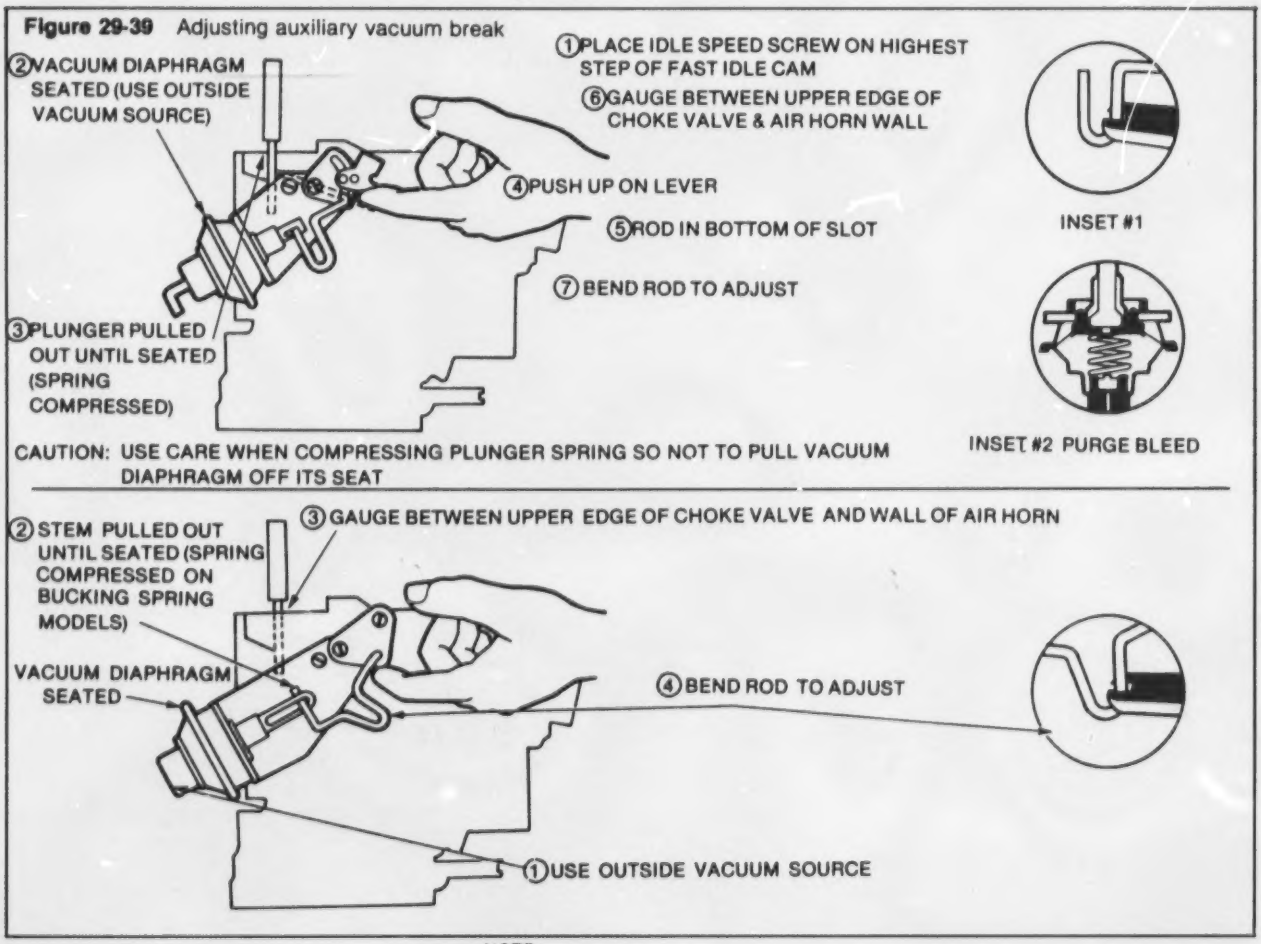


STEP 6 ***Bend link (or rod) to adjust.*** This step usually has an illustration to show you where to adjust the bend. Figure 29-38 is just one example.

These six steps complete the vacuum-break adjustment for one type of automatic choke unit. If you understand these steps, you should be able to follow most other steps listed in a technical service manual for this adjustment.

You may also need to adjust an auxiliary vacuum break. The auxiliary vacuum break is located on the choke coil side of the carburetor. Figure 29-39 shows a typical procedure for adjusting an auxiliary vacuum break on two types of automatic choke units. Read each step in these sample procedures.

Figure 29-39 Adjusting auxiliary vacuum break


①PLACE IDLE SPEED SCREW ON HIGHEST STEP OF FAST IDLE CAM
②VACUUM DIAPHRAGM SEATED (USE OUTSIDE VACUUM SOURCE)
③PLUNGER PULLED OUT UNTIL SEATED (SPRING COMPRESSED)
④PUSH UP ON LEVER
⑤ROD IN BOTTOM OF SLOT
⑥GAUGE BETWEEN UPPER EDGE OF CHOKE VALVE & AIR HORN WALL
⑦BEND ROD TO ADJUST
INSET #1
INSET #2 PURGE BLEED
CAUTION: USE CARE WHEN COMPRESSING PLUNGER SPRING SO NOT TO PULL VACUUM DIAPHRAGM OFF ITS SEAT
②STEM PULLED OUT UNTIL SEATED (SPRING COMPRESSED ON BUCKING SPRING MODELS)
③GAUGE BETWEEN UPPER EDGE OF CHOKE VALVE AND WALL OF AIR HORN
VACUUM DIAPHRAGM SEATED
④BEND ROD TO ADJUST
①USE OUTSIDE VACUUM SOURCE

NOTE:
If purge filter is used (see inset No. 2), remove vacuum break diaphragm hose and rubber cover on filter element from vacuum break tube and, using a small piece of tape, plug the small bleed hole. After adjustment, remove the tape, making sure the small bleed hole is open and install rubber cover over filter element on vacuum break tube. Reconnect vacuum hose.

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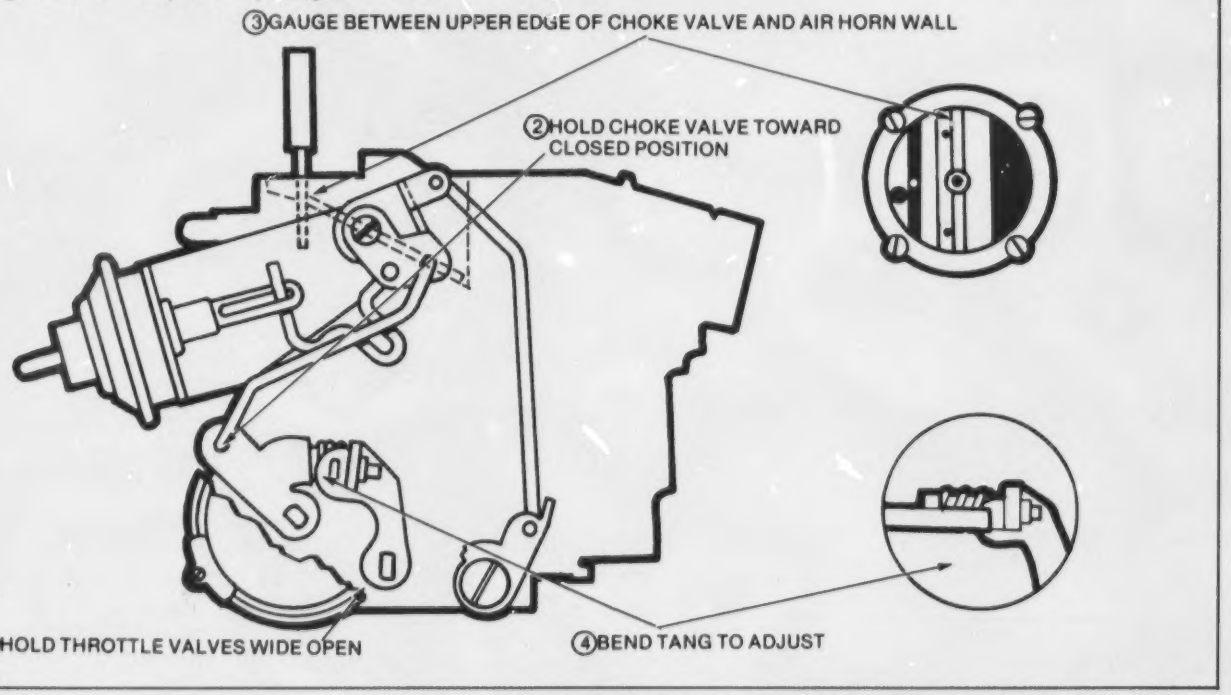
Adjusting the unloader

Remember to check the technical service manual for the gauge size to use in Step 3 of Figure 29-40. When completing Step 3, bend the tang only until the correctly sized gauge moves in and out of place with just a little friction on each side.

Figure 29-40 Steps for adjusting the unloader


③GAUGE BETWEEN UPPER EDGE OF CHOKE VALVE AND AIR HORN WALL
②HOLD CHOKE VALVE TOWARD CLOSED POSITION
①HOLD THROTTLE VALVES WIDE OPEN
④BEND TANG TO ADJUST

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NOTE: The choke valve will change position as you bend the tang. Be sure to hold the throttle valves wide open when you do these procedures.

Making an operational check of your work

After you have made all necessary adjustments, check to be sure all the components have been reassembled.

STEP 1 With the engine cold, open the carburetor throttle part way. Check to see whether the choke closes.

STEP 2 Open the throttle all the way, and check to see whether the choke unloader opens the choke valve part way.

STEP 3 Start the engine and check to see whether the choke opens during the warm-up period.

This section included only the basic adjustment procedures needed for most carburetors. Some adjustments, such as contour (synchronization) adjustment and vacuum-switch adjustment, would be made on dual carburetors, but not on most of the carburetors you'll be working with. For information on how to make other adjustments, find information about the carburetor you're working on in a technical service manual.

Turn to your Review Exercise Book and complete Exercise 19.

WORK ACTIVITIES

Do not begin any of these work activities until you have your instructor's approval. If you have any difficulty, review the pages listed next to each work activity. If you still have difficulty, ask your instructor for help.

7. Inspect and clean the parts of a vacuum-break automatic choke unit. (pages 107-108) *Check your work with your instructor.*

8. Adjust the intermediate choke rod on a vacuum-break automatic choke unit to manufacturer's specifications. (pages 108-110) *Check your work with your instructor.*

9. Adjust the choke coil (thermostatic) on a vacuum-break choke unit to manufacturer's specifications. (page 110) *Check your work with your instructor.*

10. Adjusts the choke coil rod on a vacuum-break automatic choke to manufacturer's specifications. (page 110) *Check your work with your instructor.*

11. Adjust the choke rod (fast idle cam) on a vacuum-break automatic choke unit to manufacturer's specifications. (page 110) *Check your work with your instructor.*

12. Adjust the vacuum break and the auxiliary vacuum break (if there is one) to manufacturer's specifications. (page 111-113) *Check your work with your instructor.*

13. Adjust the unloader on a vacuum-break automatic choke unit to manufacturer's specifications. (page 114) *Check your work with your instructor.*

14. Make an operational check of your work. (page 114) *Check your work with your instructor.*

After you have finished these activities, ask your instructor to return your pretest on Performance Objective 29. Complete the questions that you missed or were unable to answer the first time you took the pretest. Check your answers with your instructor when you finish. Your instructor will then tell you if you are ready to be checked off on the performance checklist or if you need to correct some of your answers first.

If you are told by your instructor that you are ready for the performance checklist, carefully tear the checklist out of your Review Exercise Book and give it to your instructor.

PERFORMANCE OBJECTIVE 30

REMOVE AND INSTALL THE CARBURETOR

INTRODUCTION TO P.O. 30

In this performance objective, you'll learn how to remove and install a carburetor. The carburetor adjustments you made in the work activities for the previous performance objective did not require the removal of the carburetor. However, there are other adjustments that must be made with the carburetor off the engine.

You may find it helpful to review Performance Objective 28. There you will find information on adjusting carburetor idle mixture screws and idle speed screws. These adjustments must be made after installing a carburetor.

After you have finished all the work activities for Performance Objective 30, your instructor will use a checklist like the one below to evaluate your work.

PERFORMANCE CHECKLIST—P.O. 30

The instructor will provide either a live vehicle or shop engine. Remove and replace the carburetor. All of the performances below must be accomplished.

Student Performances

1. Removes carburetor air cleaner assembly.
2. Marks all wires, hoses, and lines.
3. Disconnects fuel lines, hoses, wires, and linkages.
4. Removes hold-down bolts. Removes carburetor and drains fuel from float bowl.
5. Cleans off old carburetor mounting gasket and installs new gasket.
6. Reinstalls carburetor and tightens bolts in proper sequence.
7. Attaches all linkages, wires, hoses, and lines.
8. Installs carburetor air cleaner assembly.
9. Adjusts idle speed and mixture as necessary.
10. Uses proper tools and equipment.
11. Follows all appropriate safety precautions.
12. Does performance in an acceptable amount of time.

Instructor Ratings

Acceptable	Not Acceptable	Omit

SAMPLE

Tools and Equipment

For this objective, you will need to use the tools and equipment listed below. You will be given the procedures for using special tools and equipment as you work through the activities.

Basic Hand Tool Set

Special-Purpose Hand Tools

flare-nut wrench

Basic Equipment

fender covers
extension light

Reading List

If you would like additional information as you work through this performance objective, use the references below.

General References

Crouse, *Automotive Mechanics,* pp. 195-96.
Stockel, *Auto Service and Repair,* pp. 20-29.

Special-Purpose Reference

Crouse and Anglin, *Automotive Fuel, Lubricating, and Cooling Systems,* pp. 198-200.

Personal and Service Safety Practices

Safety When Working around Fuel

- Work only in well-ventilated areas.
- Never light a match or cigarette, or cause any other spark or flame while you are servicing the carburetor.
- Always clamp flexible fuel lines before disconnecting them. This will keep excess fuel from dripping out.
- Always plug steel fuel lines after disconnecting them. This will keep excess fuel from dripping out.
- Always use the droplight carefully when removing and installing the carburetor. If you drop and break the light, the fuel can ignite and cause an explosion and fire.
- Be sure you have a fire extinguisher that can handle Class B fires.

Safety in Work Clothing and Grooming

- Do not wear loosely fitting clothing or loosely hanging long hair—both can get caught in equipment. If your hair is longer than conventional length (over shirt collar), wear a hair net or keep it under a hat.

Safety When Connecting and Disconnecting Fuel Lines

- Use a flare-nut wrench on the fittings so that you will not round off the fitting edges. This is important when you are loosening or tightening a fitting.
- Be sure to match the threads of the fittings squarely when you are trying to connect them. If you cross the threads, the poor connection that results will ruin the fittings. It will also cause a fuel leak.

Safety When Removing the Carburetor

- After removing the carburetor, place masking tape or rags over the intake manifold to keep out dirt and other matter.
- Place a note on the vehicle's steering wheel stating that the carburetor has been removed. If the engine is cranked with the carburetor out, fuel will squirt out and create a safety hazard.

REMOVING THE CARBURETOR

STEP 1 Check the carburetion section of a technical manual for the vehicle you're working on. You probably won't find a list of steps for removing or installing the carburetor, but you will find a diagram of the air cleaner, the carburetor, and the connecting hoses. Figure 30-1 shows a carburetor with the air cleaner assembly removed.

Figure 30-1 Carburetor with air cleaner assembly removed

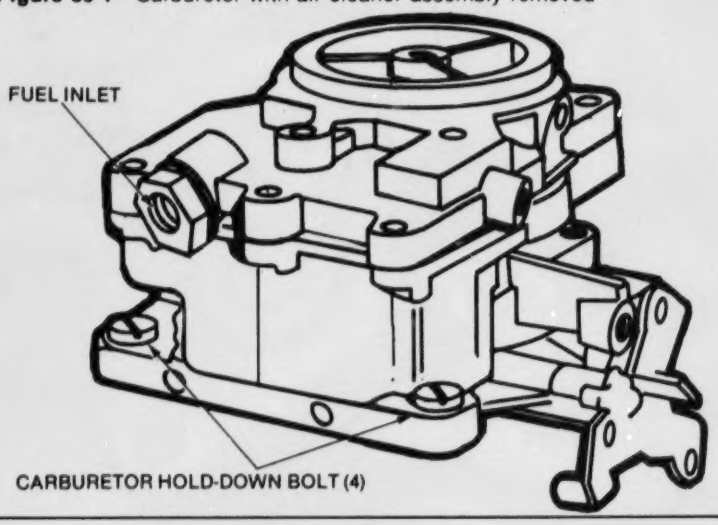
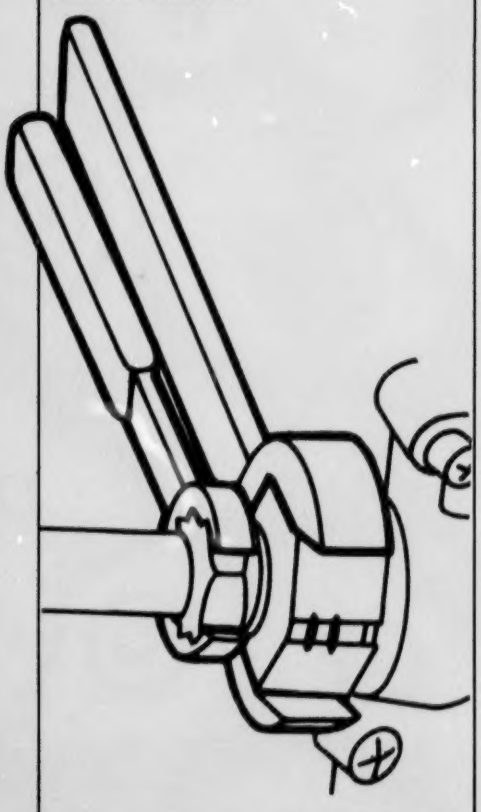


Figure 30-2 Disconnecting the fuel line from the carburetor



STEP 2 Remove the carburetor air cleaner. Then remove the air cleaner gasket from the carburetor air horn. (Put the gasket in a safe place since you will use it again.)

STEP 3 Disconnect the fuel lines and hoses connected to the carburetor (see Figure 30-2).

STEP 4 Remove the connecting hoses and lines, and mark them carefully with masking tape so that you'll know where to reconnect them.

STEP 5 Remove any wires connected to the carburetor. Mark them carefully with masking tape so that you'll know where to reconnect them.

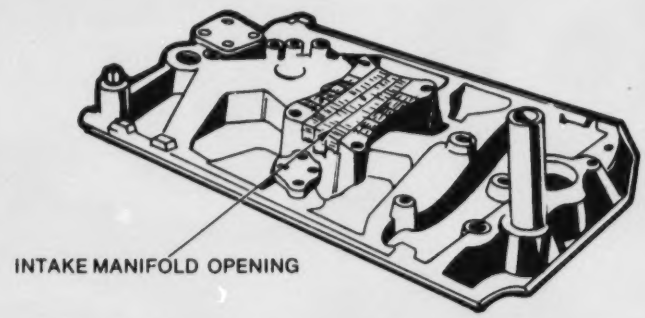
STEP 6 Disconnect the accelerator and the choke linkage from the carburetor.

STEP 7 Use the proper hand tools to remove the carburetor hold-down bolts.

STEP 8 Lift the carburetor from the vehicle, and drain the gasoline from the float bowl.

STEP 9 Place rags or masking tape over the intake manifold to keep dirt and other matter from falling into the intake manifold once the carburetor is removed (see Figure 30-3).

Figure 30-3 Cover the intake manifold opening with rags or masking tape



STEP 10 On the vehicle's steering wheel, place a note stating that the carburetor has been removed.

INSTALLING THE CARBURETOR

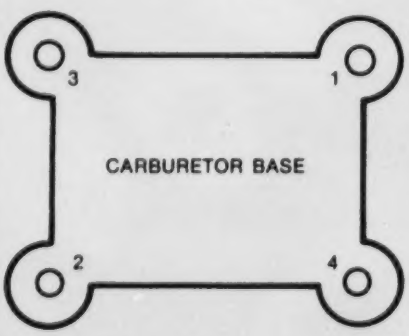
STEP 1 Be sure to replace a defective carburetor with the correct type and model of carburetor. The identification number on the new carburetor should be the same as the number on the old one. From the old carburetor, transfer any parts that are needed on the new one.

STEP 2 Remove the carburetor mounting gasket from the intake manifold. Be careful not to let pieces of the old gasket fall into the intake manifold.

STEP 3 Place a new gasket over the intake manifold.

STEP 4 Reinstall the carburetor, and tighten the hold-down bolts evenly, as shown in Figure 30-4. Tighten the bolts securely, but don't overtighten them or you'll warp the carburetor base.

Figure 30-4 Sequence for tightening the carburetor hold-down bolts



STEP 5 Use the proper tools to reconnect the fuel lines to the carburetor.

STEP 6 Reconnect the wires to the carburetor.

STEP 7 Reconnect the vacuum lines and hoses to the carburetor.

STEP 8 Reinstall the carburetor air cleaner gasket on top of the carburetor air horn. Install the carburetor air cleaner.

STEP 9 Complete the final carburetor idle adjustments.

- Attach a tachometer or an engine analyzer to the engine.
- Look up the vehicle manufacturer's specifications and procedures for adjusting the idle mixture and idle speed settings.
- Start the engine and let it warm up to operating temperatures before you make any adjustments.
- Check the HC and CO levels with an exhaust emission analyzer.

Turn to your Review Exercise Book and complete Exercise 20.

WORK ACTIVITIES

Do not begin any of these work activities until you have your instructor's approval. If you have any difficulty, review the pages listed next to each work activity. If you still have difficulty, ask your instructor for help.

1. **Remove the carburetor from a vehicle engine. (pages 122-123)** *Check your work with your instructor.*

2. **Reinstall or replace a carburetor on a vehicle engine, and complete the final carburetor idle adjustments. (pages 123-124)** *Check your work with your instructor.*

After you have finished these activities, ask your instructor to return your pretest on Performance Objective 30. Complete the questions that you missed or were unable to answer the first time you took the pretest. Check your answers with your instructor when you finish. Your instructor will then tell you if you are ready to be checked off on the performance checklist or if you need to correct some of your answers first.

If you are told by your instructor that you are ready for the performance checklist, carefully tear the checklist out of your Review Exercise Book and give it to your instructor.

PERFORMANCE OBJECTIVE 31

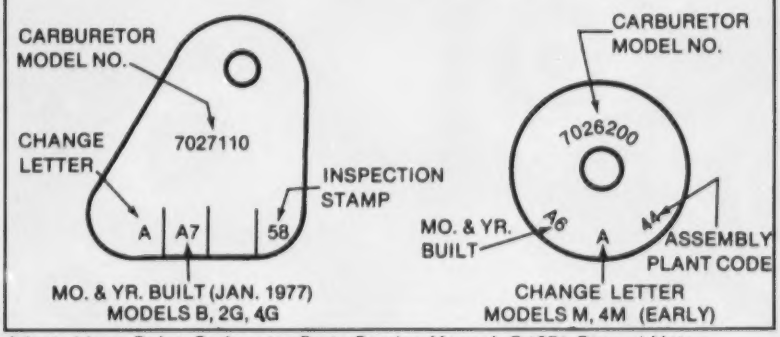
CLEAN AND OVERHAUL THE CARBURETOR

INTRODUCTION TO P.O. 31

You'll find instructions in the carburetion section of a technical service manual that tell you how to overhaul a particular carburetor. The major steps involved are disassembly, cleaning and inspection, reassembly, and adjustment of the carburetor components.

The carburetor's model number is stamped on the tag attached to the carburetor. Refer to this number and to the make of the carburetor when you get new parts or a rebuilding kit for the carburetor you're working on (see Figure 31-1).

Figure 31-1 Metal tag identification for a carburetor



Adapted from *Delco Carburetor Parts Service Manual.* ©1971 General Motors Corporation. Used with permission of Delco-Remy Division, General Motors Corporation.

After you have finished all the work activities for Performance Objective 31, your instructor will use a checklist like the one following to evaluate your work.

PERFORMANCE CHECKLIST—P.O. 31

The instructor will provide a carburetor. Clean and overhaul the carburetor. All of the performances below must be accomplished.

Student Performances	Instructor Ratings		
	Acceptable	Not Acceptable	Omit
1. Disassembles carburetor.			
2. Cleans and inspects parts for damage or wear.			
3. Replaces any worn or defective parts.			
4. Reassembles throttle body, float bowl, and air horn assemblies.			
5. Adjusts float bowl assembly.			
6. Installs air horn assembly.			
7. Completes carburetor assembly.			
8. Makes all necessary adjustments according to manufacturer's procedures and specifications.			
9. Uses appropriate tools and equipment.			
10. Follows all appropriate safety precautions.			
11. Does performance in an acceptable amount of time.			

SAMPLE

Tools and Equipment

For this objective, you will need to use the tools and equipment listed below. You will be given the procedures for using special tools and equipment as you work through the activities.

Basic Hand Tool Set

Basic Equipment

compressed air hose
compressed air gun

Safety Equipment

eye protection

Reading List

If you would like additional information as you work through this performance objective, use the references below.

General References

Crouse, *Automotive Mechanics,* pp. 196-99.
Ellinger, *Automechanics,* pp. 144-47.
Stockel, *Auto Service and Repair,* p. (20-28).
Toboldt and Johnson, *Automotive Encyclopedia,* pp. 229-57, 275-81.

Special-Purpose References

Ellinger, *Automotive Systems: Fuel, Lubrication, and Cooling,* pp. 73-100.
Crouse and Anglin, *Automotive Fuel, Lubricating, and Cooling Systems,* pp. 56-63, 66-128, 198-215.

Personal and Service Safety Practices

Safety When Working with Fuel

- Always work in well-ventilated areas.
- Always clamp flexible fuel lines before disconnecting them. This will keep excess fuel from dripping out.
- Always plug steel fuel lines after disconnecting them. This will keep excess fuel from dripping out.
- Always use the droplight carefully when removing and installing the carburetor. If you drop and break the light, the fuel can ignite and cause an explosion or fire.
- Be sure you have a fire extinguisher that can handle Class B fires.

Safety in Work Clothing and Grooming

- Do not wear loose fitting clothing or loosely hanging long hair—both can get caught in equipment.

- Keep your hair under a hat if it's longer than conventional length (over shirt collar).

Safety Practices When Connecting and Disconnecting Fuel Lines

- Use a flare-nut wrench on the fittings so that you will not round off the fitting edges. This is important when you're loosening or tightening a fitting.
- Be sure to match the threads of the fittings squarely when you're trying to connect them. If you cross the threads, the poor connection that results will ruin the fittings. It will also cause a fuel leak.

Safety When Working with Caustic Solutions

- Wear rubber gloves, a rubber apron, and eye protection when you use the carburetor cleaner.
- Carefully follow all safety precautions listed with the carburetor cleaner.

Safety When Removing a Carburetor

- Place masking tape or rags over the intake manifold after you've removed the carburetor.
- Place a note on the vehicle's steering wheel stating that the carburetor has been removed. If the engine is cranked with the carburetor out, fuel will squirt out and create a safety hazard.

DISASSEMBLING THE CARBURETOR

After removing the carburetor from the vehicle, you can begin to disassemble (take apart) the carburetor components. Use the following information as a guide for the steps you'll need to follow.

Preparing for Disassembly

STEP 1 Be sure to find the correct carburetor overhaul section in a technical service manual for the model and make of the carburetor you're working on.

STEP 2 Find an exploded diagram of the carburetor you're working on. Such a diagram shows how all the components can be taken apart. You may not need to take apart all the components. You can use the diagram, however, to help you follow the instructions in the technical service manual that refer to the components you do need to disassemble.

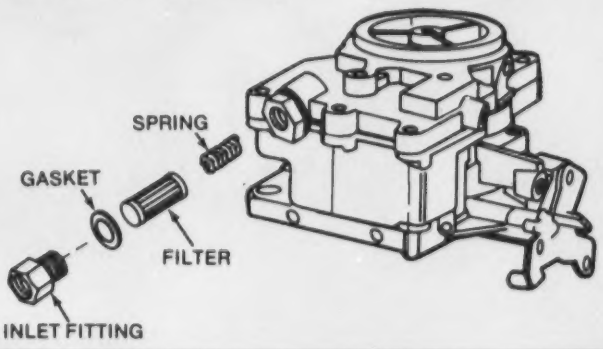
STEP 3 Locate four or five shallow pans or one large pan that is separated into several compartments. (A muffin pan works well.) The pans will be used to set

aside, separate, and store the carburetor parts as you disassemble the carburetor.

CAUTION: To prevent damage to the carburetor internal jets, always use tools of the correct size when you remove the jets.

Disassembling the Air Horn (Figure 31-2)

Figure 31-2 Carburetor with fuel filtering parts removed

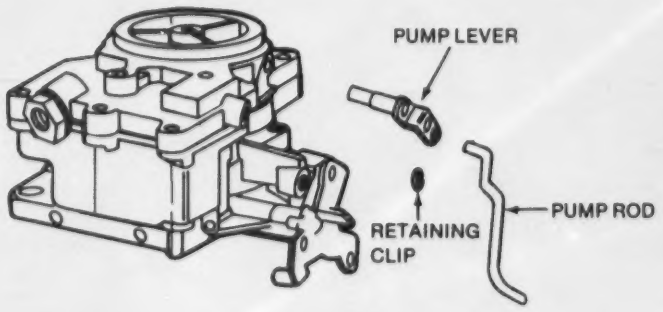


STEP 1 Remove:

- the fuel inlet fitting
- the inlet gasket
- the fuel filter
- the inlet spring

STEP 2 Remove the upper retaining clip on the pump rod. Then pull the pump rod out from the top of the pump lever (see Figure 31-3).

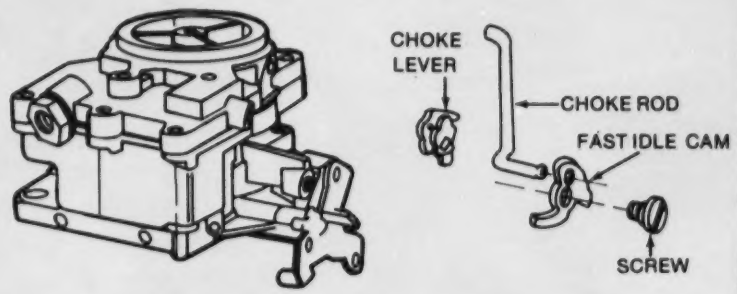
Figure 31-3 Removing the retaining clip from the pump rod



STEP 3 Remove the choke rod assembly (see Figure 31-4).

- Remove the screw attached to the fast idle cam.
- Remove the fast idle cam.
- Turn the choke rod until the lug at the bottom of the rod goes through the slot in the lower choke lever and collar (see Figure 31-4).

Figure 31-4 Removing the choke rod assembly



STEP 4 Remove the vacuum-break assembly (see Figure 31-5).

- Remove any vacuum-break hoses.
- Remove any screws that attach the vacuum break to the carburetor.
- Remove the vacuum break.

Figure 31-5 Removing the vacuum-break assembly

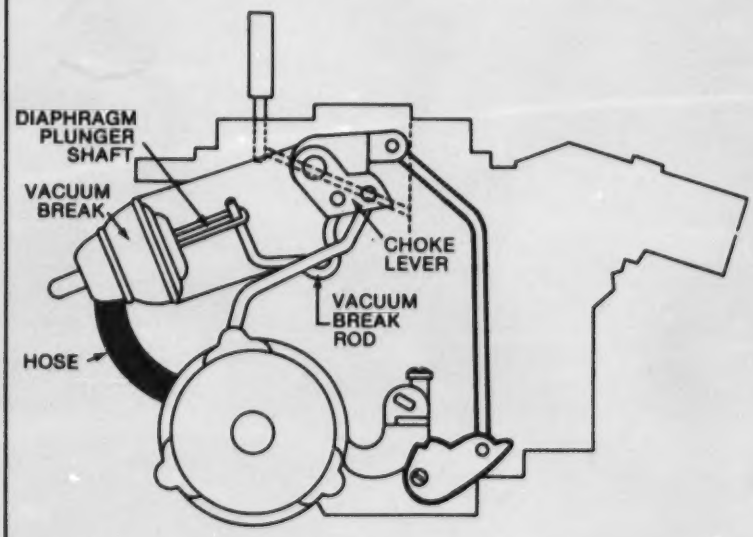


Figure 31-6 Removing the air horn screws

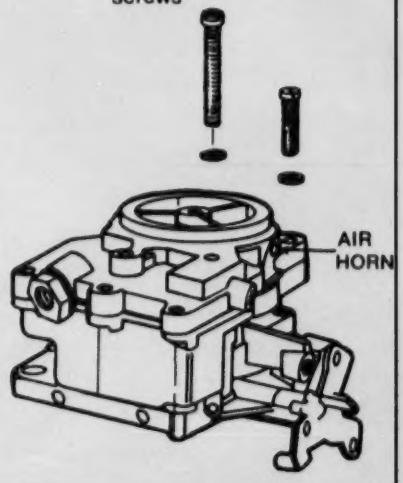
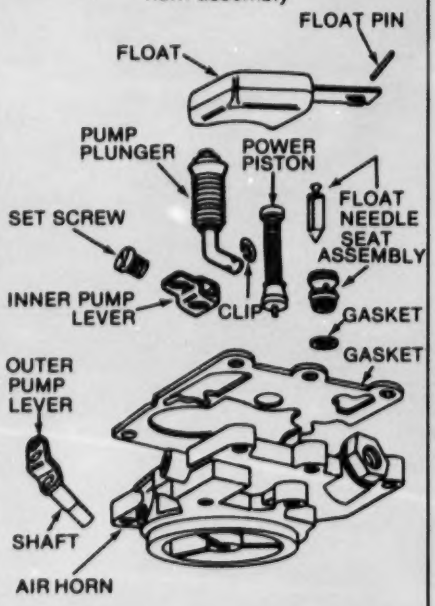


Figure 31-7 Removing parts from the air horn assembly



- Turn the vacuum-break rod until the upper end of the rod slides out of the choke lever and the lug on the other end slides out of the diaphragm plunger shaft.
- Remove the secondary vacuum-break unit (if there is one) in a similar manner.

STEP 5 Remove the screws that attach the air horn to the carburetor, and lift off the air horn (see Figure 31-6).

NOTE: Observe and remember the length of the attaching screws so you can replace them in the correct holes.

STEP 6 Place all these carburetor air horn parts together in one of the storage pans.

Removing the Float Assembly, Power Piston, Pump Plunger, and Lever from the Air Horn (See Figure 31-7)

NOTE: As you remove the following carburetor float assembly parts, place them together in one of the storage pans.

STEP 7 Turn the air horn over and remove:

- the float pin from the float hinge
- the float assembly
- the float needle seat assembly and gasket
- the power piston (depress the piston stem and let it snap free)
- the pump plunger (remove the hairpin clip and remove the pump assembly)
- Loosen the set screw on the inner pump lever, and remove the outer lever and shaft assembly.
- Remove the air horn gasket.

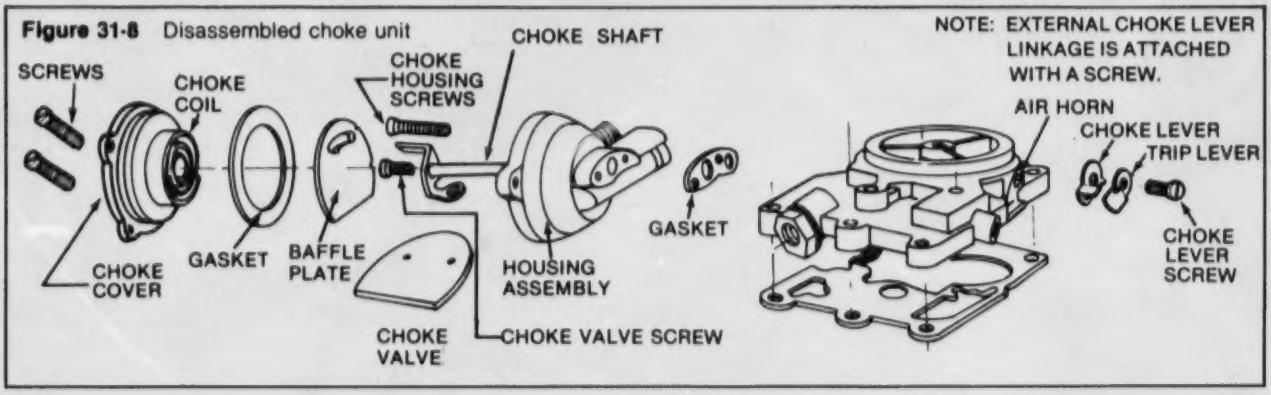
STEP 8 Remove the choke assembly from the air horn (see Figure 31-8). If the external choke lever linkage is attached to the shaft with a *screw*, as shown in the figure, then remove:

- any screws that attach the choke cover to the carburetor
- the choke cover retainer
- the choke cover and coil assembly
- the inner gasket
- the baffle plate
- the choke valve retaining screws
- the choke valve
- the choke lever screw, the trip lever, and the choke

- the lever
- the choke shaft
- the choke housing
- the choke housing screws
- the choke housing gasket

NOTE: Remember the position of the choke lever in relation to the trip lever so you will be able to put both of them back in the correct position.

Figure 31-8 Disassembled choke unit



The external choke lever linkage is sometimes *peened* to the shaft (see Figure 31-9). If this is the case, the order of removal will be different. Remember to put the choke assembly parts together in one of the storage pans. When the choke assembly is at the base of the carburetor, it may be necessary to remove the dust seal between the housing assembly and the carburetor. You may also need to remove these components in a different sequence.

When the external choke lever linkage is peened to the shaft, remove:

- the screws that attach the choke to the carburetor
- the choke cover and coil assembly
- the inner gasket
- the baffle plate
- the choke piston lever screws and the choke lever
- the choke piston and pin (remove the housing plug only if the choke piston bore needs to be cleaned)
- any retaining screws and retainers
- the choke housing screws and the choke housing
- the choke housing gasket
- the choke valve retaining screws
- the choke valve
- the choke shaft

Figure 31-9 Disassembled choke unit with a peened shaft

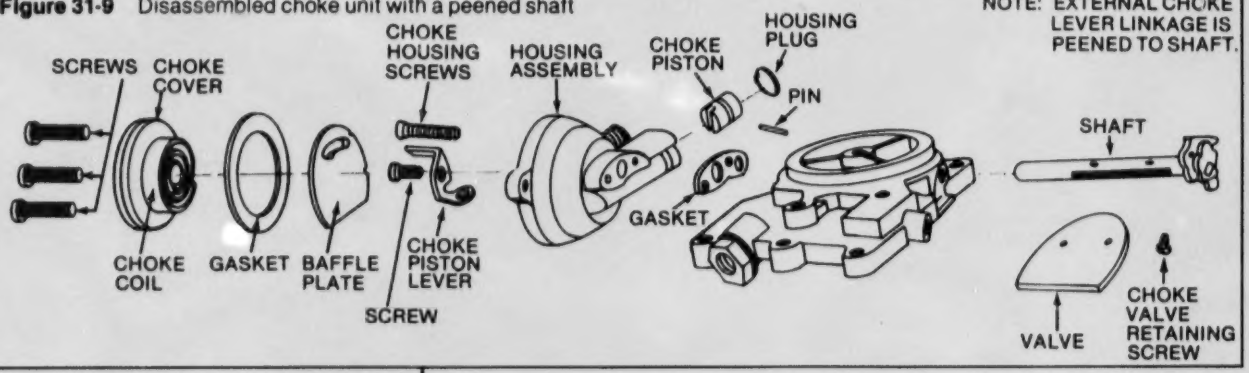


Figure 31-10 Carburetor with pump return spring and screen

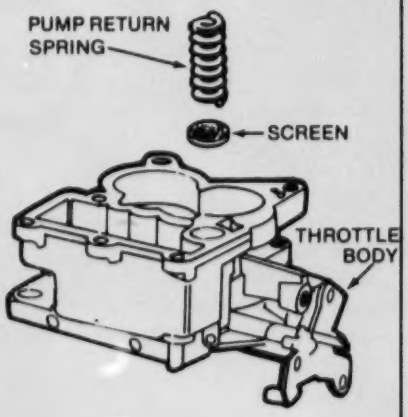
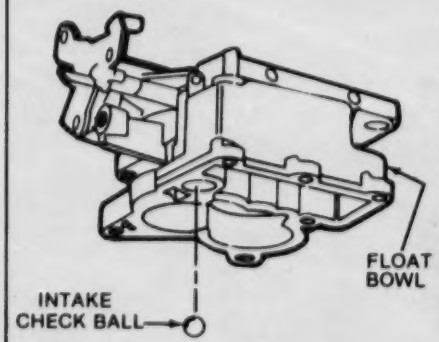


Figure 31-11 Removing the intake check ball



Disassembling the Float Bowl and Throttle Body

Be sure to put the carburetor parts into two separate pans: one for the carburetor float bowl assembly parts, and one for the throttle valve body and the idle mixture screw components.

STEP 1 Remove the pump return spring and the pump inlet filter screen, if there is one (see Figure 31-10).

STEP 2 Turn the float bowl assembly over and shake the intake check ball (if there is one) into your hand (see Figure 31-11).

STEP 3 Remove all of the following parts (see Figure 31-12):

- the main jets
- the power valve
- the gasket
- any screws attaching the venturi cluster to the carburetor
- the venturi cluster
- the venturi gasket

STEP 4 Remove all of the following parts (see Figure 31-13):

- the plastic or metal mainwell inserts
- the T-shaped pump discharge retainer guide (use needle-nose pliers to remove this T-shaped retainer guide)
- the pump discharge return spring

STEP 5 Remove the hot idle compensator (see Figure 31-14).

- Remove the screw(s) that hold the hot idle compensator cover to the carburetor.
- Remove the screw(s) that hold the bimetal spring and valve to the carburetor.

Figure 31-12 Removing the venturi cluster and related parts

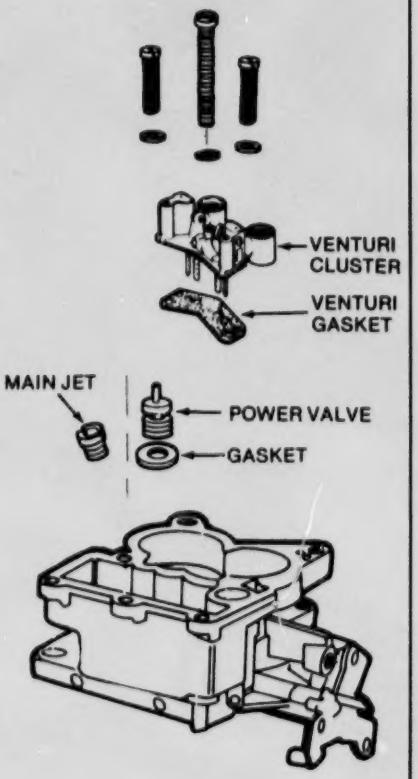


Figure 31-13 Removing the mainwell insert, retainer guide, and pump discharge return spring

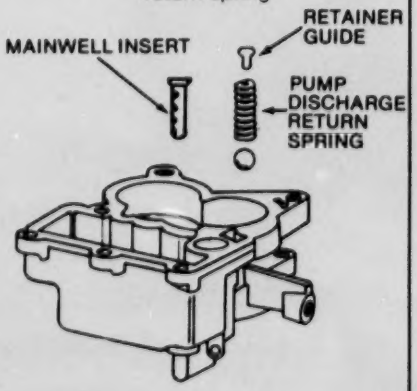


Figure 31-14 Removing the hot idle compensator

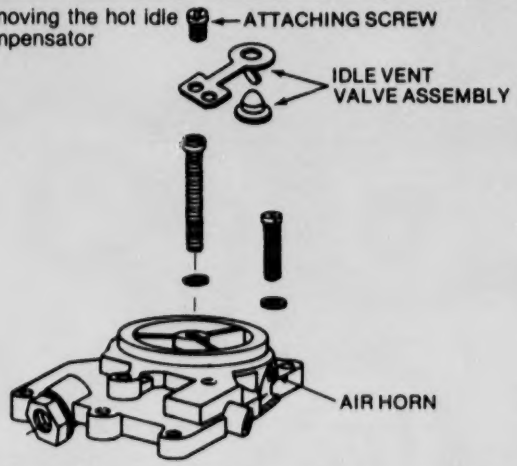
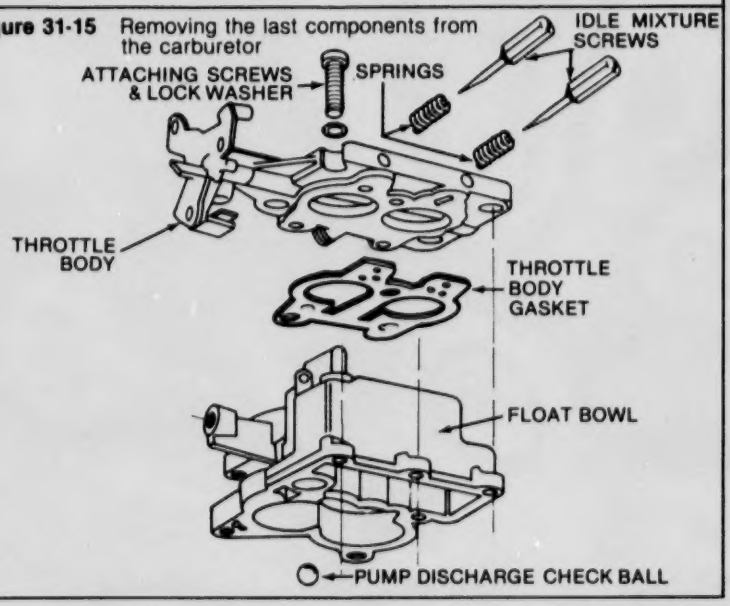


Figure 31-15 Removing the last components from the carburetor



STEP 6 Turn the carburetor float bowl assembly over (see Figure 31-15) and remove:

- the pump discharge check ball
- any screws attaching the throttle body to the float bowl
- the throttle body
- the idle mixture limiters, springs, and screws
- any throttle body gaskets

Turn to your Review Exercise Book and complete Exercise 21.

WORK ACTIVITIES

Do not begin any of these work activities until you have your instructor's approval. If you have any difficulty, review the pages listed next to each work activity. If you still have difficulty, ask your instructor for help.

1. **Remove the carburetor air horn. (pages 131-133)** *Check your work with your instructor.*
2. **Remove the following components from the air horn (pages 133-135):**
   - **float assembly**
   - **power piston**
   - **pump plunger**
   - **pump lever**
   - **choke assembly**

   Check your work with your instructor.
3. **Disassemble and remove the float bowl from the throttle body. (pages 135-136)** *Check your work with your instructor.*

After you have finished these activities, go on to the next section.

CLEANING AND INSPECTING THE CARBURETOR COMPONENTS

When overhauling the carburetor, you can use a carburetor overhaul tune-up kit. This kit contains new parts that should be used to replace some of the old parts in the carburetor.

CAUTION: Be sure all of the following components are removed from the carburetor before you start to clean it with carburetor cleaning solvent:

- all plastic, neoprene, rubber, and electrical parts (switches, relays, etc.)
- all gaskets
- the choke cover
- the coil assembly
- the pump plunger
- the vacuum-break diaphragm
- the hot idle compensator valve and spring

DO NOT clean any of these parts in carburetor cleaning solvent.

STEP 1 Soak all carburetor castings and metal parts in carburetor cleaning solvent for at least half an hour. Then remove the castings and parts and wash them with a water hose.

To use the special carburetor cleaner:

Figure 31-16 Carburetor cleaning solvent kit

- Place all of the carburetor parts that are to be cleaned into the wire basket furnished with the cleaner (see Figure 31-16).
- Slowly lower the basket into the cleaner and install the cleaner cover.

NOTE: Always place the cover back over the cleaner. Never leave the cleaning solvent exposed to dirt, dust, or moisture because the solvent will become contaminated.

STEP 2 Carefully blow out all passages with compressed air. Use a flashlight to be sure the passages are clean.

CAUTION: Do not point the air gun at anyone.

CAUTION: Never clean jets or nozzles with drills or wires. This could enlarge the openings and make the fuel mixture too rich.

STEP 3 Clean the vacuum-break diaphragm with a clean cloth.

STEP 4 Inspect and test the vacuum-break diaphragm for damage and leaks. Use a vacuum pump tester to apply 10 psi of vacuum to the diaphragm unit. If the vacuum pump tester gauge shows a steady or quick drop in psi, replace the diaphragm unit.

STEP 5 Inspect all parts for wear and damage.

- Inspect the float for dents or for wear at the pin holes. Shake the float to check for leaks.
- Inspect the idle mixture needles for wear and ridges.
- Inspect all linkage and linkage arms for wear and free movement.
- Inspect the throttle valves for wear.
- Inspect the throttle shaft for wear.

Turn to your Review Exercise Book and complete Exercise 22.

WORK ACTIVITIES

Do not begin any of these work activities until you have your instructor's approval. If you have any difficulty, review the pages listed next to each work activity. If you still have difficulty, ask your instructor for help.

4. **Clean the carburetor castings and metal parts. (page 137-138)** *Check your work with your instructor.*
5. **Clean and test the vacuum-break diaphragm. (page 137-138)** *Check your work with your instructor.*
6. **Inspect all parts for wear and damage. List any defects you find. (page 138)** *Check your work with your instructor.*

After you have finished these activities, go on to the next section.

REASSEMBLING THE CARBURETOR

Always use new gaskets, and be sure that the new gaskets match the old ones. Replace all worn and damaged parts with new ones. Always use the new parts in a carburetor tune-up kit when you reassemble the carburetor components.

The parts that are usually included in the carburetor tune-up kit are:

- jets
- gaskets
- washers
- needle and seat
- pump assembly
- pump check balls
- pump check ball spring

Set aside the new parts (from the carburetor tune-up kit) so you can match them to the old parts (from the carburetor).

NOTE: Although the kit doesn't contain a fuel filter, always replace the old fuel filter with a new one when you overhaul the carburetor.

Reassembling the Throttle Body (See Figure 31-17)

STEP 1 Install the mixture screws and springs, but do not tighten them. Seat them lightly; screw them in only until you feel a slight stop at the screws.

STEP 2 Back the mixture screws out only two turns. Do not install new limiter caps until the idle mixture settings have been completed.

STEP 3 Turn the float bowl over and place a new throttle

body gasket over the locating dowels (if it is equipped with locating dowels).

NOTE: Locating dowels are projecting pins that ensure that the throttle body gasket is properly positioned.

STEP 4 Install the throttle body assembly over the gasket.

Figure 31-18 Carburetor stand

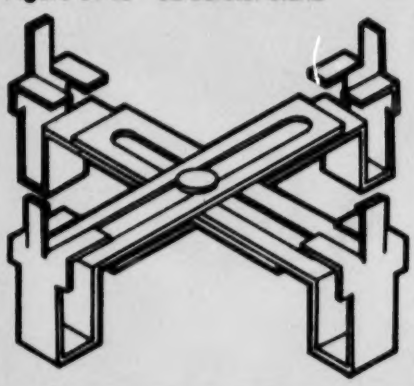


Figure 31-19 Inserting the mainwell insert tubes

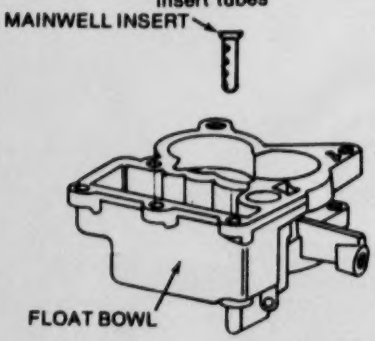


Figure 31-20 Installing the retainer, spring, and check ball

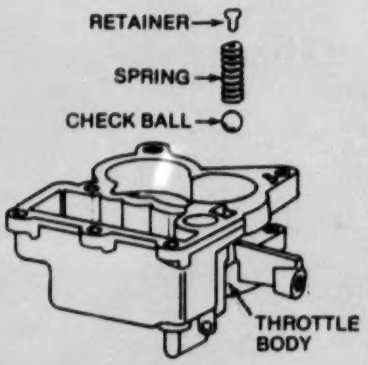
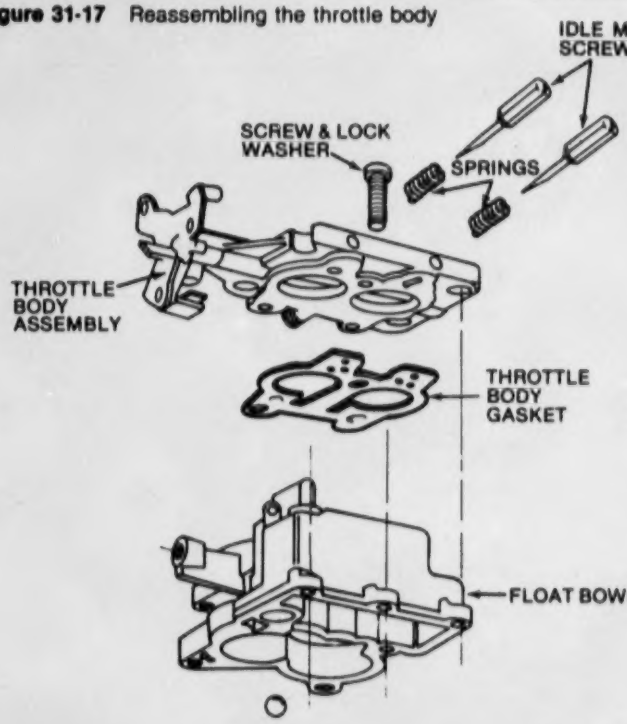


Figure 31-17 Reassembling the throttle body



STEP 5 Tighten the attaching screws evenly and securely.

Reassembling the Float Bowl

Before continuing the assembly of the float bowl, mount the carburetor base and float assembly on the carburetor stand (see Figure 31-18).

STEP 1 Install any mainwell insert tubes used with the carburetor (see Figure 31-19).

NOTE: Some carburetors don't have mainwell insert tubes.

STEP 2 Install the pump discharge check ball, spring, and T-shaped retainer (see Figure 31-20).

- Be sure you place the 3/16 inch ***steel*** ball in the discharge passage. (Don't get it mixed up with the ***aluminum*** inlet check ball.)

Figure 31-21 Installing the gasket and venturi cluster

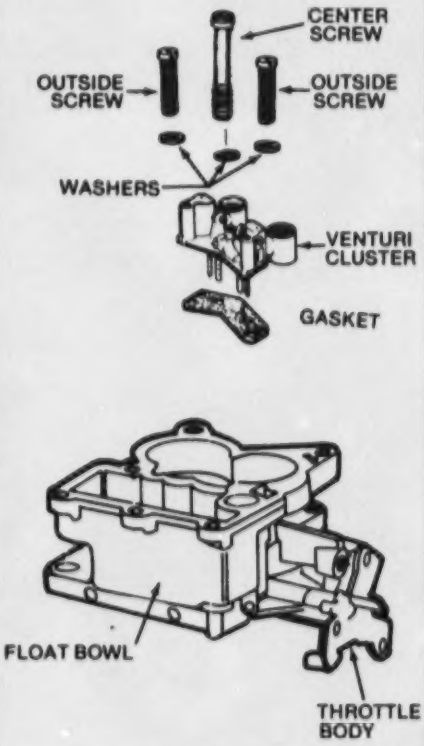
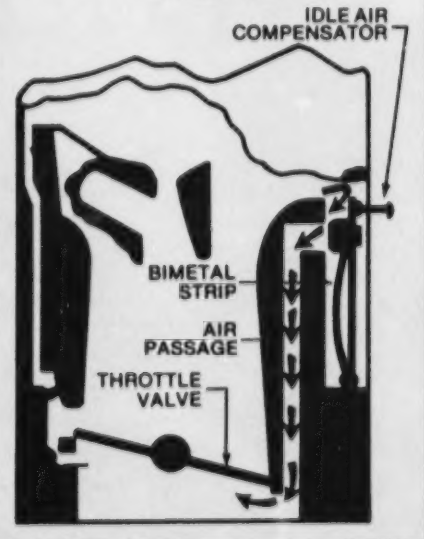


Figure 31-22 Installing the hot idle compensator



- Be sure that the top of the retainer is flush with the top of the float bowl.

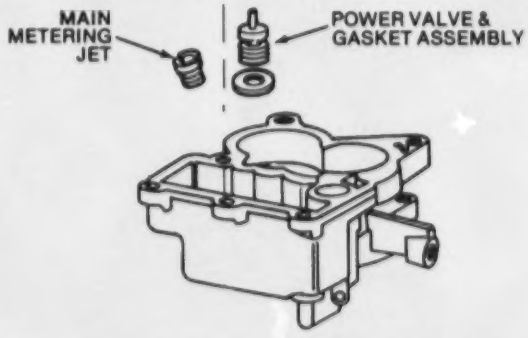
STEP 3 Install the gasket and venturi cluster (see Figure 31-21).

Place the center screw (the one with the smooth shank) and the fiber washer in the correct position through the center of the venturi cluster and gasket. Install the outside screws. Then tighten all three screws evenly and securely.

STEP 4 Install the hot idle compensator gasket and assembly (if the carburetor is so equipped). The gasket and assembly is installed on the side of the carburetor (see Figure 31-22).

STEP 5 Install the power valve with a new gasket and install two main metering jets (see Figure 31-23).

Figure 31-23 Installing the power valve and main metering jet



STEP 6 Install the inlet check ball, the inlet screen (if there is one), and the pump return spring (see Figure 31-24).

Figure 31-24 Installing the inlet check ball, inlet screen, and pump return spring

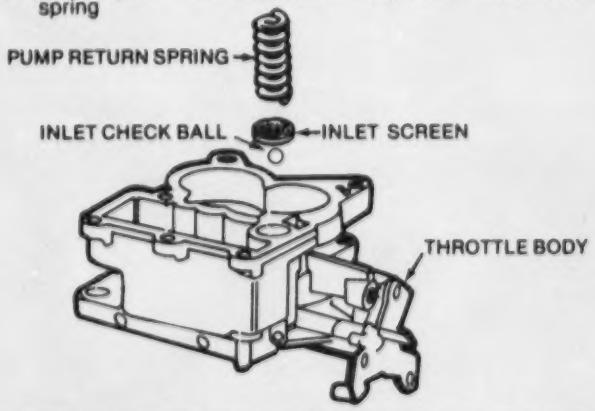
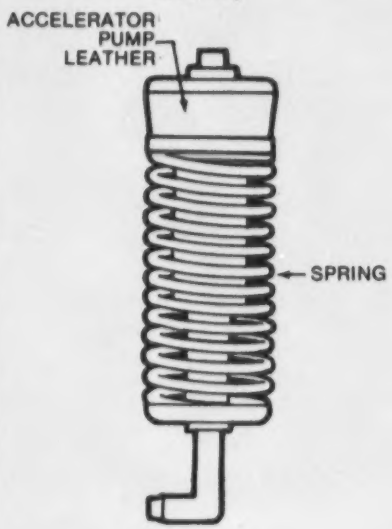


Figure 31-25 New pump plunger assembly



STEP 7 Check the pump discharge, using this procedure:

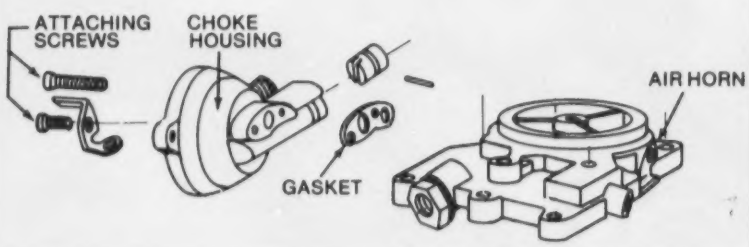
- Fill the pump well with fuel.
- Insert the pump plunger into the well.
- Force the pump up and down several times.
- Check the discharge from each jet into the venturi bores.

Reassembling the Air Horn

STEP 1 Soak the new pump plunger assembly in gasoline for about 30 minutes. This will lubricate the accelerator pump leather (see Figure 31-25).

STEP 2 Install the choke housing and the choke housing gasket with the two attaching screws. Tighten the attaching screws evenly and securely (see Figure 31-26).

Figure 31-26 Installing the choke housing and gasket

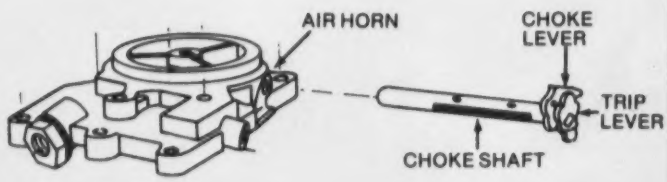


STEP 3 Install the choke piston lever assembly.

You may find the choke trip lever staked (tapped) onto the choke shaft. If this is the case, do all of the substeps described below.

- Install the choke shaft through the bores in the air horn (see Figure 31-27).

Figure 31-27 Installing the choke shaft through the bores



- Install the choke piston and pin on the choke piston lever. Place the lever and piston assembly on the end of the choke shaft. Then secure the assembly by installing the screw in the end of the shaft (see Figure 31-28).

Figure 31-28 Installing the choke piston and pin

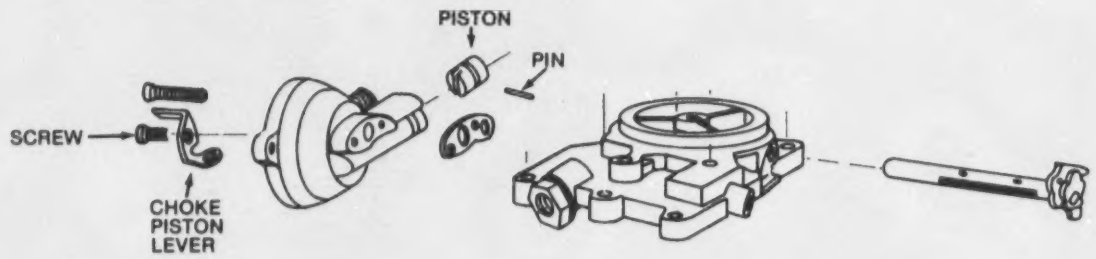


Figure 31-29 Gauging the trip lever and upper choke lever

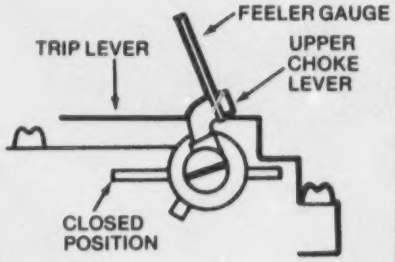
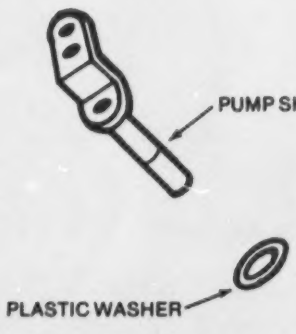


Figure 31-30 Placing a plastic washer around the pump shaft



- Insert the choke valve into the choke shaft. Be sure the "RP" or "C" trademark is in the *up* position when the choke is closed. Then install the screws, but *do not* tighten them.

STEP 4 Center the choke valve and shaft, and lightly secure the choke valve retaining screws.

- Turn the choke valve to the closed position.
- Place a feeler gauge of the correct size between the choke trip lever and the upper choke lever (see Figure 31-29). Check the technical service manual for the gauge size specifications.
- Center the choke shaft so that you keep the specified clearance between the upper choke lever and the trip lever.
- After centering the choke shaft, tighten the choke valve screws. Then stake (tap) the screws firmly, and be sure the choke valve moves freely inside the housing.

STEP 5 Install the accelerator pump.

- Lubricate the pump shaft with light oil, and place a plastic washer (if one is used) around the pump shaft arm (see Figure 31-30).
- Turn the air horn over. Hold the inner pump lever in position, and insert the pump shaft through the air horn and inner pump lever.
- Be sure to align the flat on the pump shaft with the retaining screw on the inner pump lever (see Figure 31-31). Secure the shaft by tightening the retaining screw against the flat.

Figure 31-32 Installing the power piston assembly

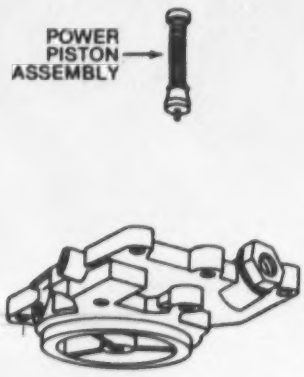


Figure 31-33 Installing the float assembly

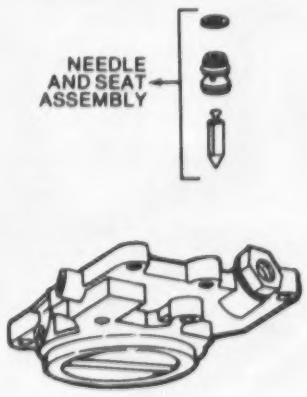


Figure 31-34 Proper placement of the retaining pin

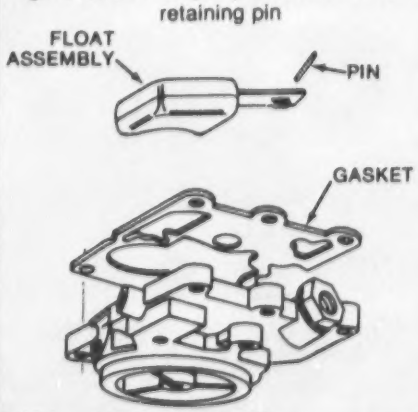
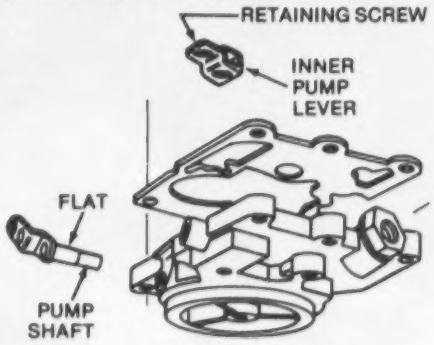


Figure 31-31 Securing the pump shaft



STEP 6 Insert the power piston in the air horn and stake it firmly (see Figure 31-32).

STEP 7 Install the float assembly (see Figure 31-33).

- Insert the needle and seat assembly. Tighten it securely with a screwdriver that has a wide blade.
- Install a new cover gasket.
- Align the float assembly and insert the retaining pin (see Figure 31-34). Be sure the float is operating freely.

STEP 8 Leave the air horn turned over, and adjust the float lever (see Figure 31-35).

- Find the float lever specification for the carburetor you're working on.
- Measure the distance from the gasket to the lip or notch on the free end of the float.
- Bend the arm as needed to meet the float level.

Figure 31-35 Adjusting the float lever

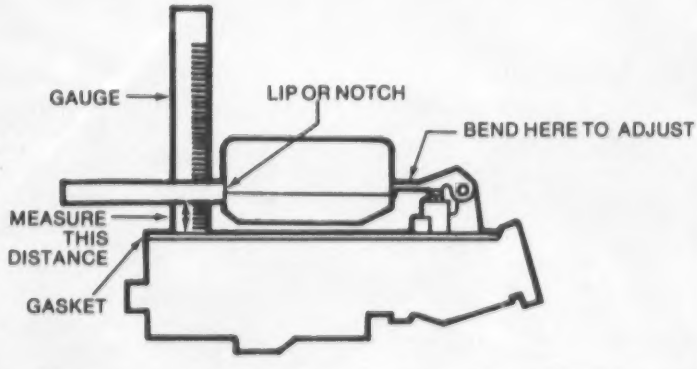


Figure 31-37 Installing the air horn assembly

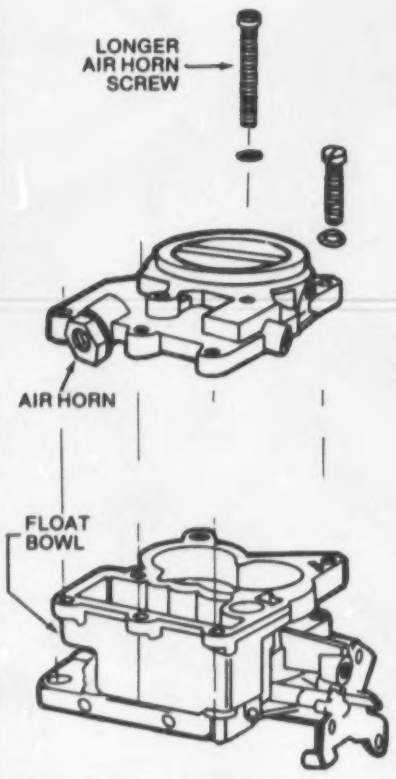
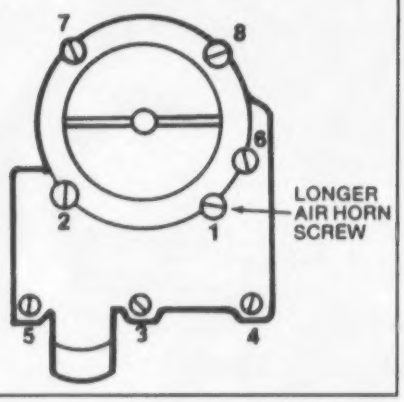


Figure 31-38 Tightening the screws when installing the air horn

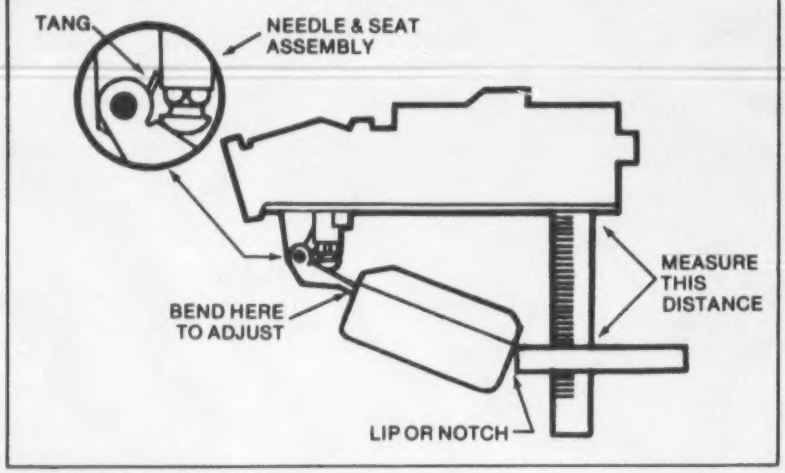


From *Delco Carburetor Parts Service Manual.* ©1973 General Motors Corporation. Used with permission of Delco-Remy Division, General Motors Corporation.

STEP 9 Turn the air horn to an upright position and adjust the float drop (see Figure 31-36).

- Find the float drop specification for the carburetor you're working on.
- Hold the air horn assembly in the normal position and measure the distance from the gasket to the lip or notch on the free end of the float.
- Bend the tang on the float as needed to meet the float drop specification.

Figure 31-36 Adjusting the float drop



CAUTION: The needle should not wedge in the seat when the float is in the maximum drop position.

CAUTION: Be sure the float is in a straight line with the air horn. (It shouldn't swing to either side.)

- If you need to adjust the float drop, be sure to repeat Step 8.

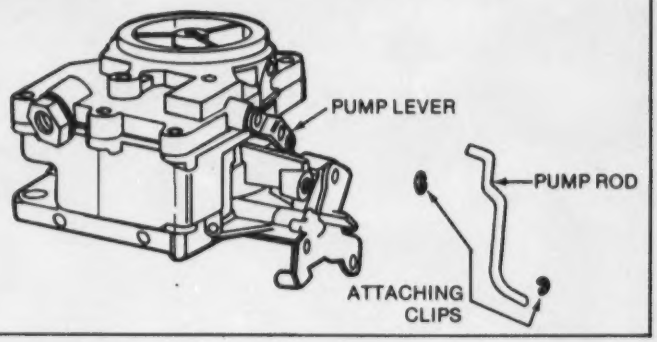
STEP 10 Attach the air horn to the float bowl, using the attaching screws and lockwashers, as shown in Figure 31-37. Tighten the screws securely, as shown in Figure 31-38.

NOTE: Place the longer air horn screw in the top of the pump housing.

STEP 11 Complete the assembly of the air horn and float bowl.

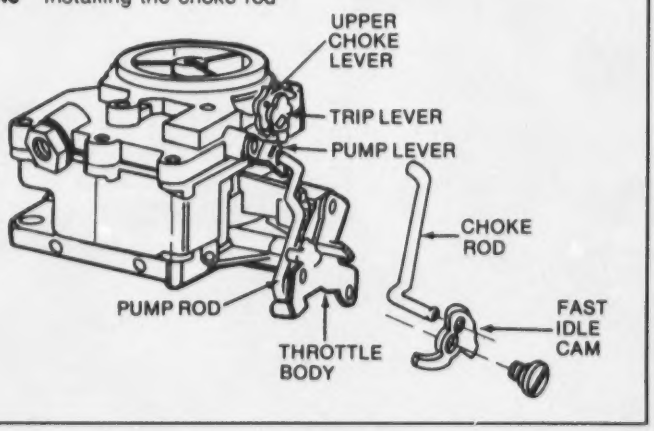
- Position the pump rod in the pump lever. Rotate the pump rod to align it with the hole in the lever. Use the pump rod attaching clips to secure the position of the pump rod (see Figure 31-39).

Figure 31-39 Attaching the pump rod to the pump lever



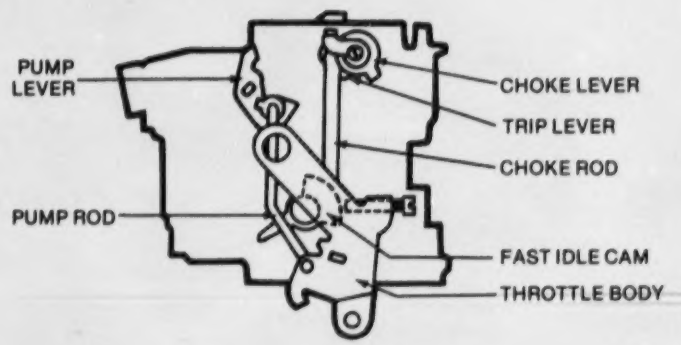
- Install the choke rod in the upper choke lever (see Figure 31-40). Rotate the choke rod to align it with the hole in the lever. Be sure the upper end of the rod faces the bore in the air horn. Then slip the fast idle cam onto the lower end of the choke rod. Be sure the "RP" or other trademark is facing outward. Finally, put a screw through the fast idle cam to attach it to the throttle body.

Figure 31-40 Installing the choke rod



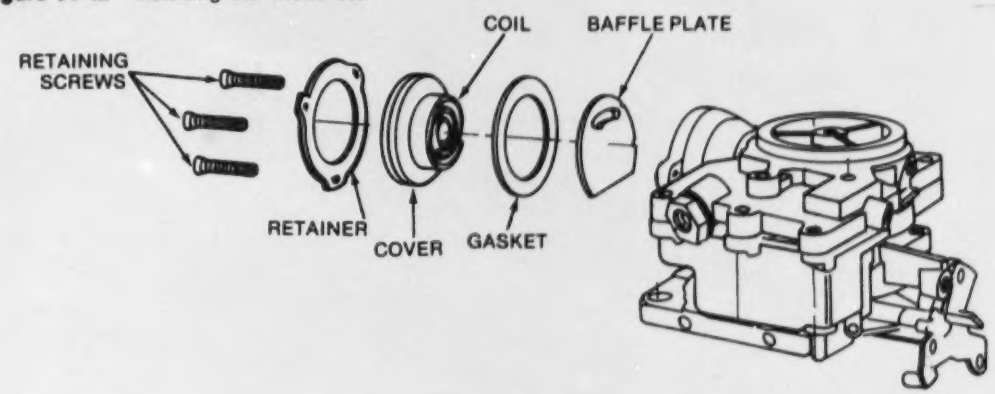
- Looking at a side view, the pump rod, the choke rod, and the fast idle cam should be in the position shown in Figure 31-41.
- Install the fuel filter.
- If the filter is of the bronze metal type, be sure the large opening faces the fuel inlet fitting.
- If the filter is the paper type, be sure the gasket end of the filter faces the fuel inlet fitting.

Figure 31-41 Correct position for the pump rod, choke rod, and fast idle cam



- Install the choke cover baffle plate and gasket, the choke coil and cover, the retainer, and the three retaining screws or clips (see Figure 31-42). Set the choke housing according to the specifications in a technical service manual.

Figure 31-42 Installing the choke coil



Making Choke Unit Adjustments

You'll need to adjust the accelerator pump rod, the fast idle (off-engine adjustment), and all other adjustments listed in Performance Objective 29.

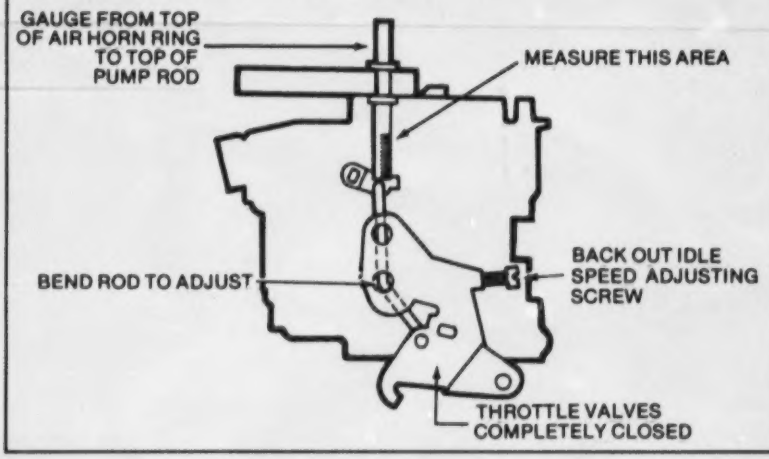
STEP 1 Adjust the accelerator pump rod.

- Find the specifications for the accelerator pump rod in the technical service manual.
- Back out the throttle stop screw and the fast idle

screw (if the carburetor has one) so that the throttle valves are completely closed.

- Measure the distance from the top of the air horn ring to the top of the pump connector rod at pump level (see Figure 31-43).
- Bend the accelerator pump rod at its curve until the distance measurement is correct according to the specifications.

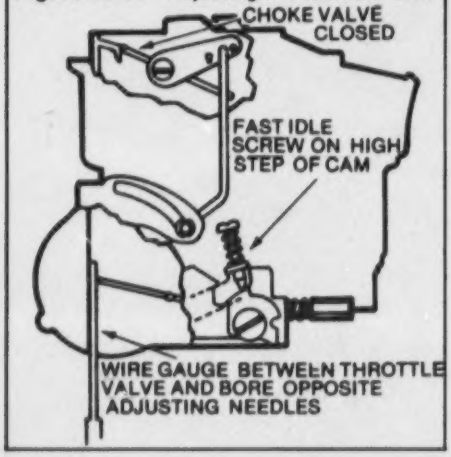
Figure 31-43 Gauging the accelerator pump rod


GAUGE FROM TOP OF AIR HORN RING TO TOP OF PUMP ROD
MEASURE THIS AREA
BACK OUT IDLE SPEED ADJUSTING SCREW
BEND ROD TO ADJUST
THROTTLE VALVES COMPLETELY CLOSED

STEP 2 Adjust the fast idle cam.

- Check the technical service manual for the carburetor on which you're working to find out if an off-engine adjustment can be made. Different adjustment procedures are specified for different carburetor models. A typical adjustment is shown in Figure 31-44.
- Close the choke valve to turn the fast idle cam so that the fast idle screw is on the high step of the cam (or other specified position).
- Check the fast idle column of the carburetor adjustment specifications to find the proper wire gauge size needed for this adjustment.
- Place the wire gauge between the throttle valve and the bore that is opposite the idle adjusting needles.
- Turn the fast idle screw until the clearance between the edge of the throttle valve and the carburetor wall is set according to specifications.

Figure 31-44 Adjusting the fast idle cam


CHOKE VALVE CLOSED
FAST IDLE SCREW ON HIGH STEP OF CAM
WIRE GAUGE BETWEEN THROTTLE VALVE AND BORE OPPOSITE ADJUSTING NEEDLES

STEP 3 Make additional adjustments as described in Performance Objective 29. (It is easier to make these

adjustments now, while the carburetor is off the engine.)

The adjustments for the piston-operated choke were considered in Performance Objective 29. They include:

- adjusting the intermediate choke rod
- setting the automatic choke (thermostat cover)
- adjusting the unloader

The adjustments for the vacuum-break-operated choke were considered in Performance Objective 29. They include:

- adjusting the intermediate choke rod
- setting the automatic choke (thermostat cover)
- adjusting the choke coil rod
- adjusting the choke rod fast idle cam
- adjusting the vacuum break
- adjusting the unloader

Turn to your Review Exercise Book and complete Exercise 23.

14~

WORK ACTIVITIES

Do not begin any of these work activities until you have your instructor's approval. If you have any difficulty, review the pages listed next to each work activity. If you still have difficulty, ask your instructor for help.

7. Reassemble the throttle body and float bowl of the carburetor. (pages 139-142) *Check your work with your instructor.*

8. Reassemble the air horn and make adjustments to meet the vehicle manufacturer's specifications. (pages 142-145) *Check your work with your instructor.*

9. Complete the assembly of the air horn to the float bowl. (pages 145-147) *Check your work with your instructor.*

10. Complete the linkage adjustments for the following parts (pages 147-149):

- **a. the accelerator pump rod**
- **b. the fast idle cam off-engine adjustment**
- **c. choke-piston unit**
  - **(1) the intermediate choke rod**
  - **(2) the automatic choke (thermostat cover)**
  - **(3) the unloader**
- **d. vacuum-break unit**
  - **(1) the intermediate choke rod**
  - **(2) the automatic choke (thermostat cover)**
  - **(3) the choke coil rod**
  - **(4) the choke rod fast idle cam**
  - **(5) the vacuum break**
  - **(6) the unloader**

Check your work with your instructor.

After you have finished these activities, ask your instructor to return your pretest on Performance Objective 31. Complete the questions that you missed or were unable to answer the first time you took the pretest. Check your answers with your instructor when you finish. Your instructor will then tell you if you are ready to be checked off on the performance checklist or if you need to correct some of your answers first.

If you are told by your instructor that you are ready for the performance checklist, carefully tear the checklist out of your Review Exercise Book and give it to your instructor.

PERFORMANCE OBJECTIVE 32
INSPECT AND REPAIR OR REPLACE THE MANIFOLD HEAT CONTROL VALVE

INTRODUCTION TO P.O. 32

In this performance objective, you'll read about the manifold heat control valve (also called a heat riser), and about its function of directing the hot exhaust gases through the engine's exhaust system. You'll also learn to inspect and service the manifold heat control valve so that it operates properly. This valve needs to be checked at every scheduled tune-up service.

While some vehicles are equipped with a manifold heat control valve, some vehicles have thermostatic air cleaners instead of a control valve. These special air cleaners will be covered in another performance objective.

After you have finished all the work activities for Performance Objective 32, your instructor will use a checklist like the one below to evaluate your work.

PERFORMANCE CHECKLIST—P.O. 32

The instructor will provide either a live vehicle or live engine. Inspect and repair or replace the manifold heat control valve. All of the performances below must be accomplished.

Student Performances	Instructor Ratings		
	Acceptable	Not Acceptable	Omit
*1. Raises vehicle as necessary.			
2. Inspects manifold heat control valve for proper operation. Notes any defects.			
3. Frees valve if stuck.			
*4. Disconnects and pulls down or removes engine exhaust pipe as necessary.			
5. Removes heat control valve part(s).			
6. Scrapes off old gasket material.			
7. Installs new gaskets, and installs heat control valve part(s).			
*8. Connects engine exhaust pipe. (Attaches intake manifold and torques as necessary.)			
9. Performs operational check of heat control valve.			
*10. Lowers vehicle as necessary.			
11. Uses proper tools and equipment.			
12. Follows all appropriate safety precautions.			
13. Does performance in an acceptable amount of time.			

SAMPLE

*These steps may vary depending upon the particular engine being used.

Tools and Equipment

For this objective, you will need to use the tools and equipment listed below. You will be given the procedures for using special tools and equipment as you work through the activities.

Basic Hand Tool Set

Basic Equipment

fender covers
extension light
hydraulic jack
jack stands

Safety Equipment

eye protection

Special Equipment

hydraulic lift

Reading List

If you would like additional information as you work through this performance objective, use the references below.

General References

Crouse, *Automotive Mechanics,* pp. 180-82.
Crouse, *The Auto Book,* pp. 208-9, 361.
Stockel, *Auto Service and Repair,* pp. (20-29)-(20-30).
Toboldt and Johnson, *Automotive Encyclopedia,* pp. 268-69.

Special-Purpose Reference

Crouse and Anglin, *Automotive Fuel, Lubricating, and Cooling Systems,* pp. 90-91.

Personal and Service Safety Practices

Safety When Working around the Manifold Heat Control Valve

- Always use fender covers when you do work under the hood. This keeps the fenders from getting scratched.
- Always use the correct tools when servicing manifold heat control valves. Using sockets and wrenches of the correct size will keep you from rounding off nuts and bolts, making them difficult to remove. Using the correct kind of hammer will keep you from breaking the exhaust manifold.

Safety When Using Hydraulic Floor Jacks and Jack Stands

- Place the jack securely under the vehicle frame. The frame provides one of the best jacking points.
- Slowly raise the vehicle with the jack. Be sure the vehicle

is properly supported on the jack.

- Always support the vehicle with the jack stand in a secure position under the vehicle. This provides added safety in case the hydraulic floor jack should fail while supporting the vehicle.
- Store the jack handle. Do not leave it on the floor. Someone could trip over it and become injured.

Safety When Using Hydraulic Lift Equipment

- Check the rated capacity of the lift.
- Never put more weight on the lift than its rated capacity. Too much weight could damage the lift or cause the lift to fail.
- Never rock the vehicle in any direction while it is on the lift. Rocking the vehicle may make it fall off the lift.
- Always be sure the vehicle is securely on the lift before raising it. This will help to keep the vehicle from falling off after it is raised.

Safety in Work Clothing and Grooming

- Always wear eye protection when working under the vehicle. Dirt and other matter can get into your eyes.
- Avoid wearing loose clothing or anything that might hang down and get caught by moving parts. Loose clothing can catch on engine parts and tear or cause you an injury.
- Keep your hair away from moving parts. If your hair is longer than conventional length, keep it under a hat.

INSPECTING THE MANIFOLD HEAT CONTROL VALVE (HEAT RISER)

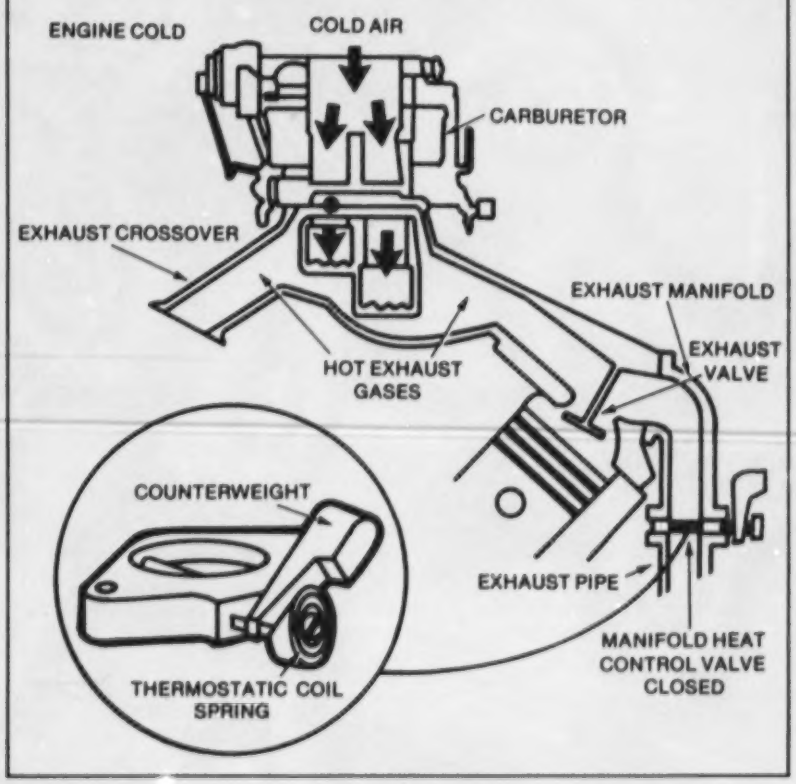
Location and Function of the Valve

The manifold heat control valve is also called a heat riser valve. On a V-8 engine, the manifold heat control valve is located between the exhaust manifold and one of the exhaust pipes (see Figure 32-1).

The function of the manifold heat control valve is to direct hot exhaust gases through the exhaust crossover so that the air-fuel mixtures are preheated while the engine is cold (see Figure 32-1).

When the engine is cold, the manifold heat control valve is closed. This sends the hot exhaust gases through the exhaust crossover (see Figure 32-1) before the gases reach the exhaust pipe and muffler. During the engine's warm-up period, the heat from these gases increases the vaporization of the fuel mixture and helps the engine to operate smoothly.

Figure 32-1 Location and operation of the manifold heat control valve

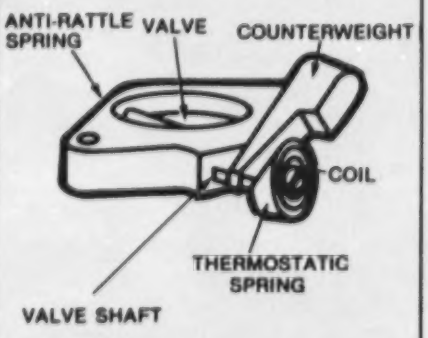


As the engine continues to warm, the thermostatic coil spring relaxes. Eventually, the counterweight, working against the coil, opens the valve and permits the hot exhaust gases to flow normally to the muffler.

On vehicles with 4- and 6-cylinder engines, the manifold heat control valve is located in the exhaust manifold, which is bolted to the intake manifold. The valve operates the same way regardless of where it is located.

Figure 32-2 shows the valve assembly.

Figure 32-2 V-8 manifold heat control valve assembly



The valve consists of:

- a thermostatic coil spring
- a counterweight
- a valve or butterfly valve
- a valve shaft
- an anti-rattle spring (on some vehicles)

Inspecting the Valve

These valves tend to become rusted in position. The constant high temperatures and acids of the exhaust gases cause the

valve to become seized or "frozen" in either an open or closed position.

If the manifold heat control valve is stuck in such a way that no heat is circulated around the intake manifold, the fuel will not be vaporized properly and fuel economy will drop.

If the manifold heat control valve is stuck in such a way that heat is circulated around the intake manifold at all times, vaporization will occur too rapidly and the engine will not develop maximum power.

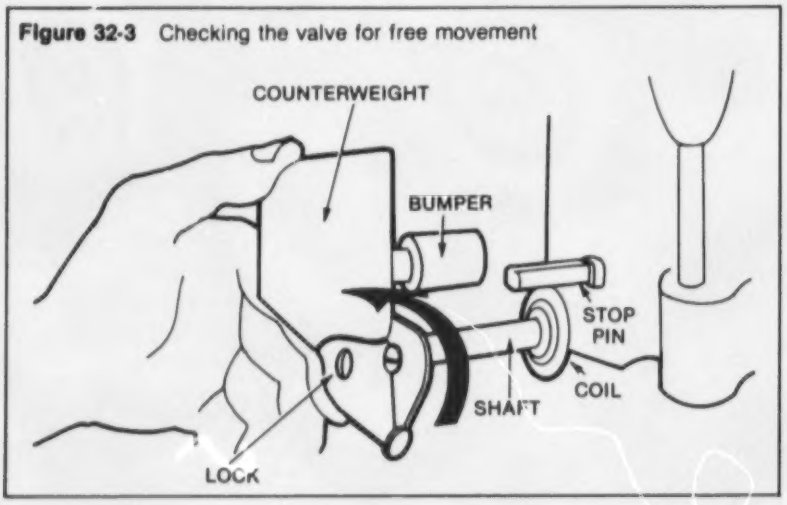
Another usual defect of the manifold heat control valve is a loose shaft, which allows exhaust gases to leak from around the ends of the shaft.

As you inspect the valve for defects, follow these steps:

STEP 1 With a 4- or 6-cylinder engine, simply locate the valve and proceed to Step 2. (You do not need to jack up the vehicle.) With most V-8 engines, you will have to inspect the manifold heat control valve from under the vehicle. In this case, lift the vehicle with a floor jack or use a hydraulic lift; then locate the manifold heat control valve.

STEP 2 Flip the counterweight back and forth with your hand to see if the valve moves freely (see Figure 32-3).

Figure 32-3 Checking the valve for free movement



STEP 3 Start the engine. Listen for exhaust gases leaking from around the ends of the shaft. An exhaust leak indicates a loose shaft, which means that the control valve will have to be replaced.

STEP 4 Accelerate the engine suddenly and watch the control valve counterweight to see if it moves. Listen also for a rattling noise coming from the

valve. A loose valve will rattle during acceleration, as well as cause an exhaust leak.

You'll learn how to service and replace the manifold heat control valve in the next part of this performance objective.

Turn to your Review Exercise Book and complete Exercise 24.

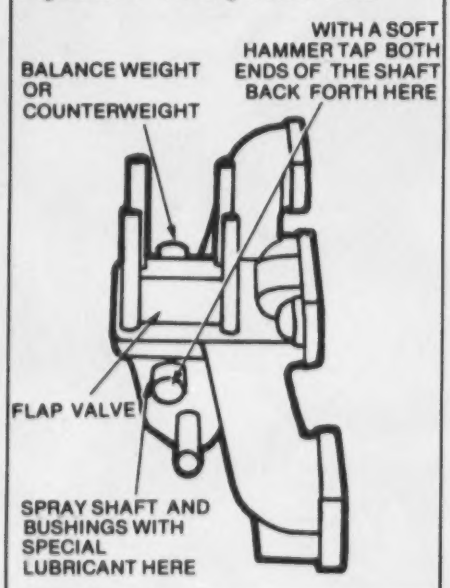
WORK ACTIVITY

Do not begin this work activity until you have your instructor's approval. If you have any difficulty, review the pages listed next to the work activity. If you still have difficulty, ask your instructor for help.

1. Inspect the manifold heat control valve and record any defects you find. (pages 155-158) *Check your work with your instructor.*

After you have finished this activity, go on to the next section.

Figure 32-4 Freeing a stuck valve


WITH A SOFT HAMMER TAP BOTH ENDS OF THE SHAFT BACK FORTH HERE
BALANCE WEIGHT OR COUNTERWEIGHT
FLAP VALVE
SPRAY SHAFT AND BUSHINGS WITH SPECIAL LUBRICANT HERE

SERVICING THE MANIFOLD HEAT CONTROL VALVE

Freeing a Stuck Valve

If your inspection shows that the manifold heat control valve is sticking or is stuck so firmly that it doesn't move, you will have to free the valve. To do that, follow these steps (see Figure 32-4):

STEP 1 Spray both ends of the shaft with "heat riser valve lubricant" only.

- *DO NOT use any other lubricant. DO NOT use oil. DO NOT use grease.*

STEP 2 After allowing the lubricant to penetrate, work the counterweight back and forth by hand until the valve operates smoothly.

STEP 3 If the valve is seized and stuck, add more lubricant. Then lightly tap the ends of the shaft back and forth with a soft (lead or brass) hammer.

CAUTION: Be sure to use only a soft hammer. Do not use a ball peen hammer. A sharp blow could break the exhaust manifold.

After you free the manifold heat control valve, check it for exhaust gas leakage past the valve shaft. If it leaks, replace it.

Replacing the Manifold Heat Control Valve

V-8 engine

The manifold heat control valve on most V-8 engines is sandwiched between the exhaust manifold and the exhaust pipe. To replace this valve follow these steps:

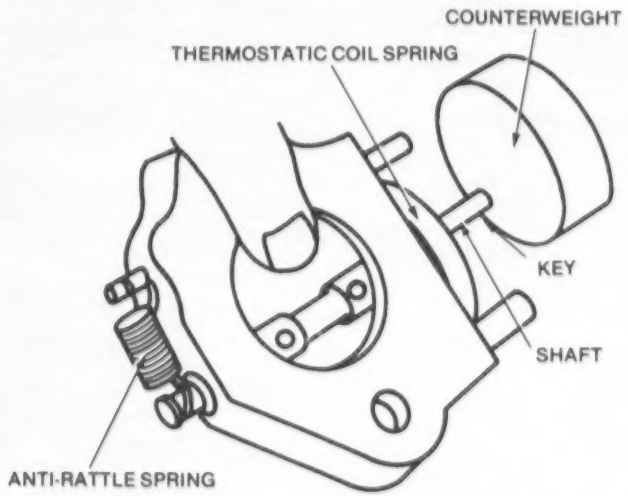
STEP 1 Use penetrating oil to lubricate the nuts and bolts that secure the valve between the exhaust manifold and pipe.

STEP 2 Using a 6-point socket, ratchet, and extension of the proper size, remove the nuts and bolts.

STEP 3 Pull down on the exhaust pipe so the manifold heat control valve assembly can be removed. Remove the valve assembly.

NOTE: Sometimes you will not be able to pull the exhaust pipe down. If that is the case, you'll have to remove the exhaust pipe.

Figure 32-5 V-8 manifold heat control valve assembly



Manifold heat control valves for V-8 engines are replaced as an assembly (see Figure 32-5). If the reason for removing the valve is to free it because it is stuck, soak the valve in carburetor cleaner. Replace the assembly if it cannot be freed.

STEP 4 Scrape off all the old gasket material from both the exhaust manifold flange and the exhaust pipe flange.

STEP 5 Using new exhaust gaskets, install the manifold heat control valve assembly between the exhaust manifold and the pipe. Make sure you have the valve assembly positioned correctly. The counterweight must be pointing up.

STEP 6 Follow the remaining steps in reverse order of the removal procedures. Use new brass nuts on the bolts. Tighten the nuts securely.

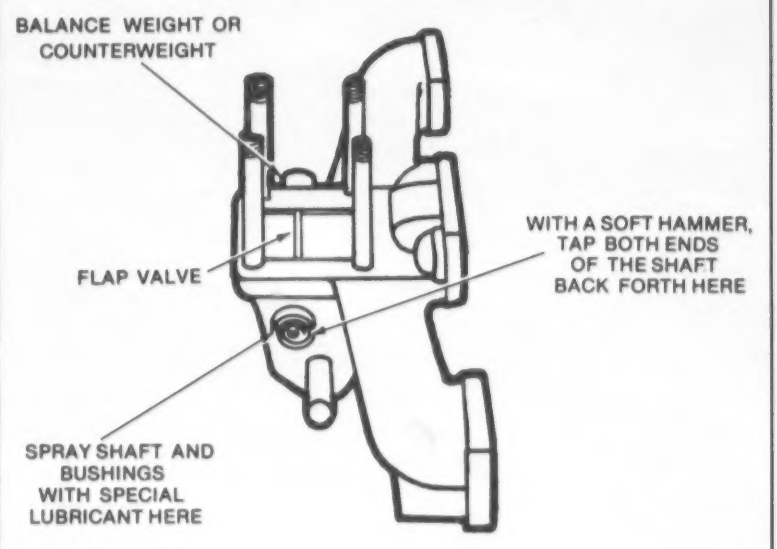
Six-cylinder and 4-cylinder engines

The manifold heat control valves on 6-cylinder and 4-cylinder engines are located in the exhaust manifold. In most cases, you'll find that if the valve needs replacing, then the entire exhaust manifold needs replacing. The shaft openings for the manifold heat control valve will usually be rusted away and enlarged so that installation of a new valve assembly will not correct the defect.

To replace these valves:

STEP 1 Separate the intake manifold from the exhaust manifold by removing all four bolts. Then remove the intake manifold to gain access to the manifold heat control valve (see Figure 32-6).

Figure 32-6 Removing intake manifold and heat control valve

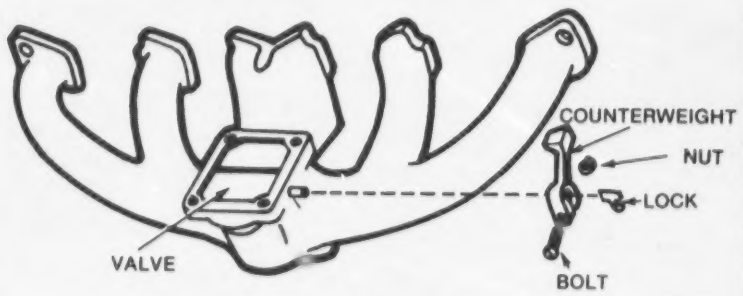

BALANCE WEIGHT OR COUNTERWEIGHT
FLAP VALVE
WITH A SOFT HAMMER, TAP BOTH ENDS OF THE SHAFT BACK FORTH HERE
SPRAY SHAFT AND BUSHINGS WITH SPECIAL LUBRICANT HERE

NOTE: On some installations, you'll find it necessary to disconnect the exhaust pipe and remove the exhaust

manifold before you can get to the manifold heat control valve. When removing and installing manifolds, ask your instructor for help.

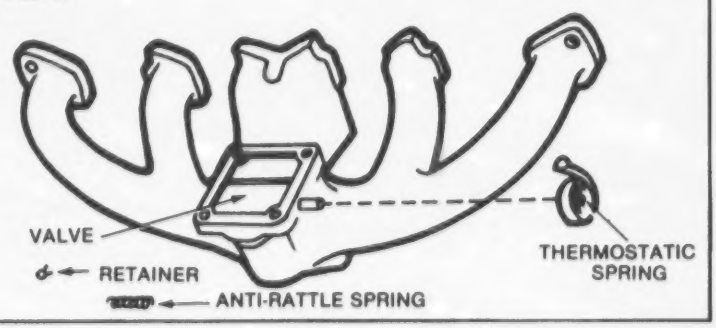
STEP 2 Disassemble the heat control valve by removing the nut and bolt that secures the counterweight to the valve shaft. Slide the lock out and pry off the counterweight (see Figure 32-7).

Figure 32-7 Removing the counterweight



STEP 3 Slip off the thermostatic spring, the anti-rattle spring, and the retainer. Notice both the position of the spring in the slot of the shaft and the way its outer end rests against the stop pin (see Figure 32-8).

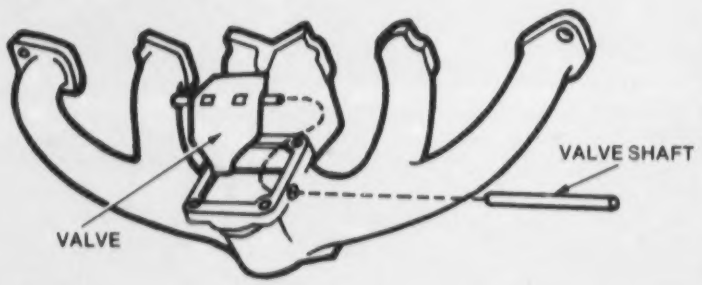
Figure 32-8 Removing the thermostatic spring, anti-rattle spring, and valve retainer



STEP 4 Pull the valve shaft away from the butterfly valve through the openings in the manifold (see Figure 32-9). On some units, the butterfly valve is attached to the shaft by two screws, so you must first remove the screws and the butterfly before you can remove the manifold heat control valve shaft.

STEP 5 To install the new manifold heat control valve parts, follow the removal procedures in reverse order.

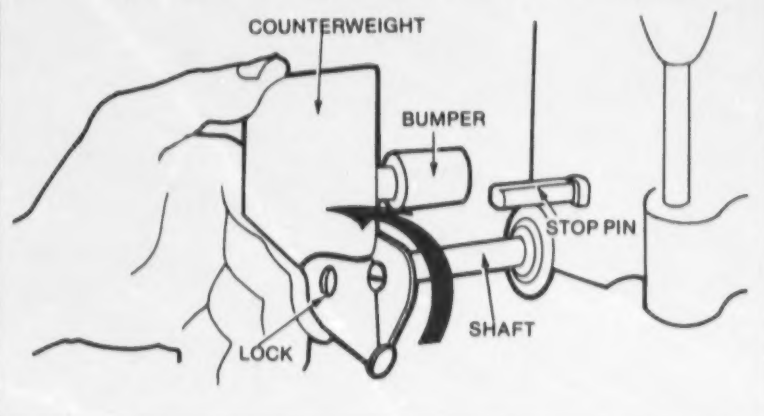
Figure 32-9 Removing the value shaft



NOTE: Upon installation of the valve shaft and butterfly valve, turn the valve shaft to its extreme clockwise position. Slip the new thermostatic coil spring into the shaft slot. Wrap the outer end of the spring ***clockwise*** and set it in place under the stop pin (see Figure 32-10).

STEP 6 Place the counterweight, large flange up, on the shaft. Slip the lock into the shaft slot. Center the counterweight on the shaft and turn it ***counterclockwise*** until the bumper passes the stop pin.

Figure 32-10 Replacing the spring, valve shaft, and counterweight



STEP 7 Press the counterweight onto the shaft until it is seated. Install the clamp bolt and nut and tighten them securely.

STEP 8 Install the anti-rattle spring on the opposite end of the shaft.

STEP 9 Check the manifold heat control valve for proper operation.

STEP 10 Reinstall the engine manifolds, using new gaskets. Follow the vehicle manufacturer's nut/bolt torque

specifications and tightening sequence.

Turn to your Review Exercise Book and complete Exercise 25.

WORK ACTIVITIES

Do not begin any of these work activities until you have your instructor's approval. If you have any difficulty, review the pages listed next to each work activity. If you still have difficulty, ask your instructor for help.

2. **Free a sticking or stuck manifold heat control valve. (page 158)** *Check your work with your instructor.*

3. **Remove and install a replaceable manifold heat control valve on a V-8 engine. (pages 159-160)** *Check your work with your instructor.*

4. **Remove and install a manifold heat control valve on either a 6-cylinder or 4-cylinder engine. (pages 160-163)** *Check your work with your instructor.*

After you have finished these activities, ask your instructor to return your pretest on Performance Objective 32. Complete the questions that you missed or were unable to answer the first time you took the pretest. Check your answers with your instructor when you finish. Your instructor will then tell you if you are ready to be checked off on the performance checklist or if you need to correct some of your answers first.

If you are told by your instructor that you are ready for the performance checklist, carefully tear the checklist out of your Review Exercise Book and give it to your instructor.